11 MECHANICAL MANUFACTURING

MACHINING TECHNIQUES

PROGRAM OF STUDY
5723

VOCATIONAL and TECHNICAL EDUCATION

Québec

MACHINING TECHNIQUES

PROGRAM OF STUDY
5723

ISBN 2-550- 35210-6

Legal Deposit – Bibliothèque nationale du Québec, 1999

MECHANICAL MANUFACTURING

MACHINING TECHNIQUES

PROGRAM OF STUDY

5723

The *Machining Techniques* program leads to the Diploma of Vocational Studies (DVS) and prepares the student to practise the trade of machinist.

Direction générale de la formation professionnelle et technique

DEVELOPMENT TEAM

Coordination	Denis Laroche Claude Proulx Coordinators of the Mechanical Manufacturing Sector
Design and Development	Robert Cabot Yvan Péloquin Teachers and Content Specialists With the participation of: Guy Larente Jacques Tremblay René Tousignant Members of the Harmonization Team
Technical Support	Louise Blanchet Technical Consultant in Program Development With the participation of: Julie Audet Manon Paquette Technical Consultants in Program Development
Translation	Services à la communauté anglophone Direction de la production en langue anglaise

Acknowledgments

The Ministère de l'Éducation wishes to thank the following people for their invaluable assistance in the development of this program:

Representatives from Business and Industry

Yvon Alix
Ajustage ALTech inc.
Cowansville

Martin Bergeron
Cammec La Baie
Ville de la Baie

André Bolduc
Atelier d'usinage Marmen inc.
Cap-de-la-Madeleine

Claude Boisvert
Bombardier Canadair
Saint-Laurent

Alain Chabot
Rotobec inc.
Sainte-Justine

Rénald Chênevert
Verbom inc.
Valcourt

François Desbiens
Société Messier Dowty
Saint-Janvier

Denis Deshaies
Usinage Meloche
Valleyfield

Richard Gosselin
Entreprise Solstice ltée
Saint-Hubert

François Gaudreau
Air/Terre équipement
Granby

Fabien Lauzé
Atelier d'usinage Aéro ltée
Montréal

Richard Leblanc
Valmet-Canada inc.
Lachine

Bernard Marceau
IBM Bromont
Bromont

Guy Parenteau
Usinage Vincent
Tracy

Paul-André Rousseau
S. Huot inc.
Québec

Luc St-Jean
Automatech Ind.
Granby

Jean Valin
Industrie Guérette inc.
Longueuil

Representatives from Education

René Bourgeois
CS de la Côte-du-sud

Pierre Boucher
CS Saint-Jérôme

Gaston Carignan
CS de Manicouagan

Herman D'Anjou
CS de Portneuf

Raymond Dion
CS Lac-Saint-Jean

Luc Gélinas
CS du Centre de la Mauricie

Normand Julien
CS de La Jeune Lorette

Yves Brousseau
CS Saint-Hyacinthe

François Laroche
CS catholique de Sherbrooke

Serge Lefebvre
CS District de Bedford

Ellamine Letaief
CS du Sault-Saint-Louis

Ghislain Magny
CS Harricana

Pierre Malenfant
CS de Rivière-du-Loup

Benoît Manseau
CS de Hull

Gaétan Meilleur
CS de l'Industrie

This program of study, *Machining Techniques*, is issued in accordance with section 461 of the *Education Act* (R.S.Q., c. I-13.3).

In conformity with the provisions of paragraph (a) of section 23 of the *Act respecting the Conseil supérieur de l'éducation* (R.S.Q., c. C-60), as replaced by section 569 of chapter 84 of the 1988 legislation, the confessional committees of the Conseil supérieur de l'éducation have given their opinion on this program of study.

TABLE OF CONTENTS

INTRODUCTION

The *Machining Techniques* program is based on a framework for developing vocational education programs that calls for the participation of experts from the workplace and the field of education.

The program of study is developed in terms of competencies, expressed as objectives. These objectives are divided into modules. Various factors were kept in mind in developing the program: training needs, the job situation, purposes, goals, and strategies and means used to attain objectives.

This program includes 26 compulsory competencies plus an optional category consisting of two 75-hour competencies. Schools may choose either of these competencies to offer as part of the program. The compulsory and optional training together comprise 27 modules and represent the minimum requirements for a Diploma of Vocational Studies (DVS) for students in both the youth and adult sectors. This program also provides the basis for organizing courses, planning teaching strategies, and preparing instructional and evaluation materials.

Regardless of the option selected, the duration of the program is 1800 hours, which includes 1200 hours spent on the specific competencies required to practise the trade and 600 hours on general competencies. The modules vary in length from 15 to 120 hours (multiples of 15). The time allocated to the program is to be used not only for teaching but also for evaluation and remedial work.

The document contains two parts. Part I is of general interest and provides an overview of the training plan. It includes a synoptic table of basic information about the modules, a description of the program training goals, the competencies to be developed and the general objectives, and an explanation of operational objectives. Part II is designed primarily for those directly involved in implementing the program. It contains a description of the operational objectives of each module. It also contains suggestions on the instructional approach and related content for each module in the program. The suggestions are intended for users of the program and are provided for informational purposes only.

In keeping with this broad approach, two accompanying documents will be provided: an evaluation guide and a planning guide.

HARMONIZATION

Machining Techniques (5723) is a vocational education program in the *Mechanical Manufacturing* sector. It was designed and developed as part of a project to harmonize the different programs in this sector, including *Mechanical Engineering Technology* and *Aircraft Manufacturing Technology* at the college level, as well as *Industrial Drafting* and *Numerical Control Machine Tool Operation* at the secondary level.

The different programs were harmonized with a view to achieving continuity between vocational and technical education. The main objective of harmonization is to encourage students to pursue their studies by optimizing their efforts, whether they are returning to school after a period of absence or taking a new career direction. Harmonization makes it possible to move from one program to another or from one level of instruction to another without repeating the same courses.

Tables of equivalents have been designed to show the relationships among the different programs that have undergone harmonization. These tables appear in the following pages.

Equivalences between programs can be of different types. Some competencies are common to several programs of study. Their content is therefore identical, and they bear the same code in all programs in a given level of instruction. Some competencies correspond to several competencies in another program or may be deemed equivalent to a competency in another program by the development team despite the fact that they are not identical. The tables in the following pages illustrate this information. For all other cases, the educational institution is responsible for evaluating and recognizing the prior learning of its students.

The following tables concern all programs involved in the harmonization process. The left-hand column contains the codes and statements of competency of the program in question. The other columns contain the codes of the equivalent competencies in the other programs. Thus, students who have acquired one or more competencies in the program in question will receive recognition for the equivalent competencies in another program if they pursue their studies in that program.

Students who have attained one or more of the competencies of the *Machining Techniques* (5723) program will receive recognition for corresponding competencies in one of the programs below, if they pursue their studies in that program.

Table 1 – Equivalents for the *Machining Techniques* program

FROM → TO					
MACHINING TECHNIQUES (DVS) 5723		**Industrial Drafting (DVS) 5725**	**Mechanical Engineering Technology (DEC) 241.A0**	**Numerical Control Machine Tool Operations (AVS) 5724**	**Aircraft Manufacturing Technology (DEC) 280.B0**
872 011	Determine their suitability for the trade and the training process			872 011	
872 024	Solve mathematical problems related to conventional machining				
872 035	Interpret technical drawings	872 035	012F		
872 041	Avoid occupational health and safety risks				
872 054	Take and interpret measurements	872 054	012P		
872 066	Do shop work				
872 072	Interpret technical information related to materials and manufacturing processes				
872 083	Sketch objects		012G		011S
872 096	Perform external cylindrical turning operations		012Q		
872 105	Perform boring operations				
872 125	Cut threads on a lathe				
872 118	Perform longitudinal and transverse machining operations on a milling machine		012R		
872 133	Perform drilling and reaming operations on a milling machine				
872 178	Perform angular and circular milling operations on a milling machine				
872 144	Grind flat surfaces				
872 153	Adapt to new types of work organization	872 153	012X	872 153	0127
872 162	Become familiar with the workplace				
872 182	Solve mathematical problems related to numerical control machining			872 303	
872 194	Program a numerical control lathe manually		0133	872 194	
872 214	Program a machining centre manually		012W	872 214	
872 206	Machine simple parts on a numerical control lathe		012V	872 206	
872 226	Machine simple parts using a machining centre			872 226	
872 238	Perform complex turning operations				
872 248	Perform complex milling operations				
872 255	Mass-produce parts using conventional machining techniques (optional)				
872 265	Perform machining operations using a boring machine (optional)				
872 271	Explore the possibility of starting their own business				
872 286	Enter the workforce			872 354	

Students who have attained one or more of the competencies of the *Industrial Drafting* (5725) program will receive recognition for corresponding competencies in one of the programs below, if they pursue their studies in that program.

Table 2 – Equivalents for the *Industrial Drafting* program

FROM →		TO			
INDUSTRIAL DRAFTING DVS 5725		**Mechanical Engineering Technology (DEC) 241.A0**	**Machining Techniques (DVS) 5723**	**Numerical Control Machine Tool Operation (AVS) 5724**	**Aircraft Manufacturing Technology (DEC) 280.B0**
872 311	Determine their suitability for the trade and the training process				
872 324	Solve problems related to industrial drafting				
872 035	Interpret technical drawings	012F	872 035		
872 335	Produce sketches	012G	872 083		011U
872 356	Produce detail drawings of mechanical components	012N			
872 395	Produce assembly drawings	012U			
872 345	Work at a computerized work station	012M			
872 364	Illustrate fasteners				
872 373	Illustrate the arrangement and movement of the components of a mechanism				
872 386	Interpret technical information about materials and manufacturing processes		872 072		
872 407	Use the specialized functions of a computer-aided drafting program	013C			
872 054	Take and interpret measurements	012P	872 054		
872 414	Determine dimensional tolerances	012S			
872 421	Correct a drawing				
872 436	Illustrate power train systems				
872 446	Produce development drawings	013B			
872 456	Make a three-dimensional model of an object	013D			
872 466	Produce detail drawings of a mechanism				
872 476	Make piping and circuit diagrams				
872 482	Use job search or entrepreneurial techniques		872 271		
872 495	Produce drawings for a mechanical system				
872 507	Draw the housing of a machine				
872 153	Adapt to the new types of work organization	012X	872 153	872 153	0127
872 517	Design a simple technical object				
872 526	Enter the work force				

Students who have attained one or more of the competencies of the *Mechanical Engineering Technology* (241.A0) program will receive recognition for corresponding competencies in one of the programs below, if they pursue their studies in that program.

Table 3 – Equivalents for the *Mechanical Engineering Technology* program

FROM → TO					
MECHANICAL ENGINEERING TECHNOLOGY (DEC) 241.A0		**Industrial Drafting (DVS) 5725**	**Machining Techniques (DVS) 5723**	**Numerical Control Machine Tool Operation (AVS) 5724**	**Aircraft Manufacturing Technology (DEC) 280.B0**
012D	Analyze the occupation				
012E	Solve problems related to industrial mechanics	872 324	872 024		011Q
012F	Interpret technical drawings	872 035	872 035		
012G	Produce sketches	872 335	872 083		
012N	Produce detail drawings of mechanical components	872 356			011U
012U	Produce assembly drawings	872 395			
012H	Interpret technical information about materials and manufacturing processes	872 386	872 072		
012J	Analyze the internal and external forces exerted on a mechanical object				011W
012K	Plan the application of heat treatments				
012L	Do the engineering design of an object's fasteners				
012M	Use a computerized work station	872 345			
012P	Take and interpret measurements	872 054	872 054		
012S	Determine dimensional tolerances	872 414			011T
012T	Determine the geometric tolerances required for an assembly				
012Q	Operate a conventional lathe		872 096 872 105		011S
012R	Operate a conventional milling machine		872 118		
012V	Operate a numerical control machine tool		872 206 872 226	872 206 872 226	
012W	Program a machining centre manually		872 214	872 214	
0133	Program a numerical control lathe manually		872 194	872 194	
0135	Do automatic programming			872 314	011Z
012X	Adapt to the new types of work organization	872 153	872 153	872 153	0127
012Y	Establish the sequence of operations for manufacturing processes				0129
0134	Develop a process sheet				
012Z	Control the quality of products				
0130	Modify the design concept of the components of a piece of industrial equipment				
0131	Do the engineering design of the tools necessary for a manufacturing project				012A
0132	Watch for new technologies				
0136	Produce the tools necessary to carry out a manufacturing project				
0137	Plan the maintenance of a machine population				
0138	Maintain manufacturing machines				

FROM →		TO			
MECHANICAL ENGINEERING TECHNOLOGY (DEC) 241.A0		**Industrial Drafting (DVS) 5725**	**Machining Techniques (DVS) 5723**	**Numerical Control Machine Tool Operation (AVS) 5724**	**Aircraft Manufacturing Technology (DEC) 280.B0**
0139	Organize the work for a medium production run				
013A	Coordinate a medium manufacturing run				
013B	Produce development drawings	872 446			
013C	Use the specialized functions of a computer-aided drawing program	872 407			
013D	Make a three-dimensional model of an object	872 456			
013E	Develop hydraulic and pneumatic circuits for industrial machines				
013F	Do the engineering design of a an industrial piping system				
013G	Do the engineering design of an industrial system				
013H	Do the engineering design of machine housings				
013J	Develop basic automated circuits				
013K	Automate an industrial system				
013L	Coordinate a design project				

Students who have attained one or more of the competencies of the *Aircraft Engineering Technology* (280.B0) program will receive recognition for corresponding competencies in one of the programs below, if they pursue their studies in that program.

Table 4 – Equivalents for the *Numerical Control Machine Tool Operation* program

FROM →		TO			
NUMERICAL CONTROL MACHINE TOOL OPERATION (AVS) 5724		**Industrial Drafting (DVS) 5725**	**Mechanical Engineering Technology (DEC) 241.A0**	**Machining Techniques (DVS)[1] 5723**	**Aircraft Manufacturing Technology (DEC) 280.B0**
872 011	Determine their suitability for the trade and the training process			872 011	
872 292	Interpret complex drawings related to numerical control machine tool operations				
872 303	Solve mathematical problems related to numerical control machine tool operation			872 182	
872 194	Program a numerical control lathe manually		0133	872 194	
872 214	Program a machining centre manually		012W	872 214	
872 314	Do automatic programming		0135		011Z
872 206	Machine simple parts on a numerical control lathe			872 206	
872 226	Machine simple parts on a machining centre		012V	3872 26	
872 328	Perform complex machining operations on a numerical control lathe				
872 338	Perform complex machining operations on a machining centre				
872 153	Adapt to the new types of work organization	872 153	012X	872 153	0127
872 346	Mass-produce parts on numerical control machine tools				
872 354	Enter the work force			872 286	

1. The *Numerical Control Machine Tool Operation* program leads to an Attestation of Vocational Specialization. Students wishing to enrol in this program must have a Diploma of Vocational Studies in *Machining Techniques* or the equivalent scholastic or experiential learning. It is inconceivable that a student study the specialty before enrolling in the basic program. The equivalents in this table are intended merely to indicate the competencies for which a student having obtained a DVS and enrolled in the AVS program would receive recognition.

Students who have attained one or more of the competencies of the *Aircraft Engineering Technology* (280.B0) program will receive recognition for corresponding competencies in one of the programs below, if they pursue their studies in that program.

Table 5 – Equivalents for the *Aircraft Manufacturing Technology* program

FROM → TO					
AIRCRAFT MANUFACTURING TECHNOLOGY (DEC) 280.B0		**Industrial Drafting (DVS) 5725**	**Mechanical Engineering Technology (DEC) 241.A0**	**Machining Techniques (DVS) 5724**	**Numerical Control Machine Tool Operation (AVS) 5723**
011P	Analyze the occupation				
011Q	Do calculations related to aeronautics	872 324			
011R	Interpret technical drawings related to aeronautics	872 035	012F	872 035	
011S	Apply the potential of machining processes		012Q 012R		
011T	Ensure the conformity of the dimensional and geometric components of aircraft	872 414	012S 012T		
011U	Produce and modify sketches, technical drawings and models related to aeronautics	872 335 872 356 872 395	012G 012N 012U		
011V	Apply the potential of forming processes				
011W	Optimize the performance of the materials used in aeronautics		012K		
011X	Establish relationships between the operational characteristics of an aircraft and construction principles				
011Y	Design and modify a detail part of an aircraft component				
011Z	Produce and modify programs for numerical control machines		012W 0133 0135		872 194 872 214 872 314
0120	Apply the potential of the forming of composites				
0121	Establish relationships between the characteristics of aircraft systems and design and planning decisions				
0122	Apply the potential of assembly processes				
0123	Design and modify aircraft components				
0124	Find and process technical information				
0125	Develop concepts and procedures related to structural repair				
0126	Contribute to the optimization of the manufacturing process	872 153	012X	872 153	872 153
0127	Interact with colleagues in various work situations				
0128	Ensure quality control		012Z		
0129	Develop and modify process sheets		0134		
012A	Design and modify production tooling for aircraft components		0131		
012B	Develop and modify specifications				
012C	Design and modify the tools required to assemble aircraft components				

GLOSSARY

Program Training Goals
Statements that describe the educational aims of a program. These goals are the general goals of vocational education adapted to a specific trade or occupation.

Competency
A set of knowledge, skills, perceptions and attitudes that enable a person to correctly perform a work-related activity or task.

General Objectives
Instructional objectives that provide an orientation for leading the students to attain one or more related objectives.

Operational Objectives
Statements of the educational aims of a program in practical terms. They serve as the basis for teaching, learning and evaluation. In the competency-based approach, the educational aims are expressed as competencies to be developed.

Module of a Program
A component part of a program of study comprising an operational objective.

Credit
A unit used for expressing quantitatively the value of the modules in a program of study. One credit corresponds to 15 hours of training. Students must accumulate a set number of credits to graduate from a program.

PART I

1. SYNOPTIC TABLE

Number of modules: 27*
Duration in hours: 1800
Credits: 120

Machining Techniques
CODE: 5723

CODE	NO.	TITLE OF THE MODULE	HOURS	CREDITS**
872 011	1	The Trade and the Training Process	15	1
872 024	2	Mathematics Related to Conventional Machining	60	4
872 035	3	Interpreting Technical Drawings	75	5
872 041	4	Health and Safety	15	1
872 054	5	Taking and Interpreting Measurements	60	4
872 066	6	Shop Work	90	6
872 072	7	Materials and Processes	30	2
872 083	8	Sketches	45	3
872 096	9	External Cylindrical Turning	90	6
872 105	10	Boring	75	5
872 118	11	Longitudinal and Transverse Machining on a Milling Machine	120	8
872 125	12	Thread Cutting on a Lathe	75	5
872 133	13	Drilling and Reaming Using a Milling Machine	45	3
872 144	14	Surface Grinding	60	4
872 153	15	New Types of Work Organization	45	3
872 162	16	Introduction to the Workplace	30	2
872 178	17	Angular and Circular Milling on a Milling Machine	120	8
872 182	18	Mathematics Related to Numerical Control Machining	30	2
872 194	19	Manual Programming of a Numerical Control Lathe	60	4
872 206	20	Basic Machining on a Numerical Control Lathe	90	6
872 214	21	Manual Programming of a Machining Centre	60	4
872 226	22	Basic Machining Using a Machining Centre	90	6
872 238	23	Complex Turning Operations	120	8
872 248	24	Complex Milling Operations	120	8
872 255	25	Mass Production (optional)	75	5
872 265	26	Using a Boring Machine (optional)	75	5
872 271	27	Entrepreneurship	15	1
872 286	28	Entering the Workforce	90	6

* The school will choose between Modules 25 and 26 depending on the needs expressed by representatives of the job market in the region.

** 15 hours = 1 credit

This program leads to a DVS in *Machining Techniques.*

2. PROGRAM TRAINING GOALS

The training goals of the *Machining Techniques* program are based on the general goals of vocational education and take into account the specific nature of the trade. These goals are:

1. **To develop effectiveness in the practice of a trade.**
   - To teach students to perform machining tasks and activities correctly, at an acceptable level of competence for entry into the job market.
   - To prepare students to perform satisfactorily on the job by fostering:
     - the intellectual and psychomotor skills needed to perform machining tasks on conventional and numerical control machine tools;
     - the ability to plan and organize their work and time in accordance with deadlines;
     - the ability to interpret drawings and solve mathematical problems related to machining;
     - a sense of responsibility and a habit of self-inspection;
     - a constant concern for occupational health and safety;
     - attention to detail and precision;
     - the development of a sense of observation and spatial perception;
     - the ability to understand instructions;
     - the ability to communicate with colleagues and superiors and to work in a team;
     - the acquisition of a technical vocabulary in English and French.

2. **To ensure integration into the job market.**
   - To familiarize students with the job market in general and the trade of machinist in particular.
   - To familiarize students with new concepts in work organization.
   - To familiarize students with their rights and responsibilities as workers.

3. **To foster personal and occupational development.**
   - To help students improve their ability to adapt to change.
   - To help students develop their autonomy so that they can find information and resource materials and become familiar with new technologies.
   - To help students understand the principles underlying the techniques used.
   - To help students develop the ability to perform more complex tasks.
   - To help students develop the desire for excellence and the basic attitudes required for success.

4. To ensure job mobility.

- To help students develop a positive attitude toward technological change, new situations and professional development.
- To help students develop problem-solving skills.
- To help students achieve the versatility required to work with conventional and numerical control machine tools.
- To help students prepare for a creative job search.
- To help students assess their potential and interest with respect to starting a business.

3. COMPETENCIES

The competencies to be developed in *Machining Techniques* are shown in the grid of learning focuses on the following page. The grid lists general and specific competencies as well as the major steps in the work process.

General competencies involve activities common to several tasks or situations. They cover, for example, the technological or scientific principles that the students must understand to practise the trade or occupation. Specific competencies focus on tasks and activities that are of direct use in the trade or occupation. The work process includes the most important steps in carrying out the tasks and activities of the trade or occupation.

The grid of learning focuses shows the relationship between the general competencies on the horizontal axis and the specific competencies on the vertical axis. The symbol △ indicates a correlation between a specific competency and a step in the work process. The symbol O indicates a correlation between a general and a specific competency. Shaded symbols indicate that these relationships have been taken into account in the formulation of objectives intended to develop specific competencies related to the trade or occupation.

The logic used in constructing the grid influences the course sequence. Generally speaking, this sequence follows a logical progression in terms of the complexity of the learning involved and the development of the students' autonomy. The vertical axis of the grid shows the competencies directly related to the practice of a specific trade or occupation. These competencies are arranged in a relatively fixed order; therefore, the modules should be taught, insofar as possible, in the order represented on the grid. The modules including the general competencies on the horizontal axis should be taught in relation to those on the vertical axis. This means that some modules are prerequisite to others, while other modules are taught concurrently.

Machining Techniques includes an optional section. Schools must select one of the two optional specific competencies (Modules 25 and 26), of a duration of 75 hours each.

GRID OF LEARNING FOCUSES Machining Techniques SPECIFIC COMPETENCIES (directly related to the practice of the specific occupation)				WORK PROCESS (major steps)							GENERAL COMPETENCIES (related to technology, subjects, personal development, etc.)													TOTALS	
		FIRST-LEVEL OPERATIONAL OBJECTIVES	DURATION (IN HOURS)	Interpret drawings and technical manuals	Plan the work	Program a machine tool	Do the work	Perform quality control tasks	Tidy up	Perform regular maintenance on the equipment	Determine their suitability for the trade and the training process	Solve mathematical problems related to conventional machining	Interpret technical drawings	Avoid occupational health and safety risks	Take and interpret measurements	Do shop work	Interpret technical information related to materials and manufacturing processes	Sketch objects	Adapt to new types of work organization	Solve mathematical problems related to numerica control machining	Program a numerical control lathe manually	Program a machining centre manually	Explore the possibility of starting their own busines	NUMBER OF OBJECTIVES	NUMBER OF OBJECTIVES
MODULES	MODULES										1	2	3	4	5	6	7	8	15	18	19	21	27		
	OPERATIONAL OBJECTIVES										S	B	B	B	B	B	B	B	B	B	B	B	S	13	
	DURATION (IN HOURS)										15	60	75	15	60	90	30	45	45	30	60	60	15		600
9	Perform external cylindrical turning operations	B	90	▲	▲		▲	▲	▲	▲	❍	●	●	●	●	●	●	●	❍						
10	Perform boring operations	B	75	▲	▲		▲	▲	▲	▲	❍	●	●	●	●	●	●	●	❍						
11	Perform longitudinal and transverse machining operations on a milling machine	B	120	▲	▲		▲	▲	▲	▲	❍	●	●	●	●	●	●	●	❍						
12	Cut threads on a lathe	B	75	▲	▲		▲	▲	▲	▲	❍	●	●	●	●	●	●	●	❍						
13	Perform drilling and reaming operations on a milling machine	B	45	▲	▲		▲	▲	▲	▲	❍	●	●	●	●	●	●	●	❍						
14	Grind flat surfaces	B	60	▲	▲		▲	▲	▲	▲	❍	●	●	●	●	●	●	●	❍						
16	Become familiar with the workplace	S	30	△	△	△	△	△	△	△	❍	❍	❍	●	❍	❍	❍	❍	●				❍		
17	Perform angular and circular milling operations on a milling machine	B	120	▲	▲		▲	▲	▲	▲	❍	●	●	●	●	●	●	●	❍						
20	Machine simple parts on a numerical control lathe	B	90	▲	▲	▲	▲	▲	▲	▲	❍	●	●	●	●	●	●	●	❍	●	●				
22	Machine simple parts using a machining centre	B	90	▲	▲	▲	▲	▲	▲	▲	❍	●	●	●	●	●	●	●	❍	●		●			
23	Perform complex turning operations	B	120	▲	▲		▲	▲	▲	▲	❍	●	●	●	●	●	●	●	❍	❍					
24	Perform complex milling operations	B	120	▲	▲		▲	▲	▲	▲	❍	●	●	●	●	●	●	●	❍	❍					
25	Mass-produce parts using conventional machining techniques (optional)	B	75	▲	▲		▲	▲	▲	▲	❍	●	●	●	●	●	●	●	●	❍	❍	❍			
26	Perform machining operations using a boring machine (optional)	B	75	▲	▲		▲	▲	▲	▲	❍	●	●	●	●	●	●	●	❍	❍					
28	Enter the workforce	B	90	△	△	△	△	△	△	△	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	●		
	NUMBER OF OBJECTIVES	14																						27	
	HOURS		1200																						1800

S: Situational objectives
B: Behavioural objectives

△ Correlation between a step and a specific competency
▲ Correlation to be taught and evaluated
❍ Correlation between a general and a specific competency
● Correlation to be taught and evaluated

4. GENERAL OBJECTIVES

The general objectives of the *Machining Techniques* program are presented below, along with the major statement of each corresponding operational objective.

To develop in the students the basic competencies required to carry out machining tasks.

- Solve mathematical problems related to conventional machining.
- Interpret technical drawings.
- Avoid occupational health and safety risks.
- Take and interpret measurements.
- Interpret technical information related to materials and manufacturing processes.
- Sketch objects.
- Solve mathematical problems related to numerical control machining.

To develop in the students the specific competencies required to perform machining tasks on conventional machine tools.

- Do shop work.
- Perform external cylindrical turning operations.
- Perform boring operations.
- Perform longitudinal and transverse machining operations on a milling machine.
- Cut threads on a lathe.
- Perform drilling and reaming operations on a milling machine.
- Grind flat surfaces.
- Perform angular and circular milling operations on a milling machine.
- Perform complex turning operations.
- Perform complex milling operations.
- Perform machining operations using a boring machine.

To develop in the students the competencies required to perform programming tasks.

- Program a numerical control lathe manually.
- Program a machining centre manually.

To develop in the students the basic competencies required to perform machining tasks on numerical control machine tools.

- Machine simple parts on a numerical control lathe.
- Machine simple parts using a machining centre.

To develop in the students the competencies required to actively participate in multidisciplinary teams.

- Adapt to new types of work organization.
- Mass-produce parts using conventional machining techniques.

To develop in the students the competencies required to integrate harmoniously into the school and work environments.

- Determine their suitability for the trade and the training process.
- Become familiar with the workplace.
- Explore the possibility of starting their own business.
- Enter the workforce.

5. OPERATIONAL OBJECTIVES

5.1 DEFINITION

An operational objective is defined for each competency to be developed. Competencies are organized into an integrated training program designed to prepare students to practise the trade or occupation. This systematic organization of competencies produces better overall results than training by isolated objectives. More specifically, it fosters a smooth progression from one objective to the next, saves teaching time by eliminating needless repetition, and integrates and reinforces learning material.

Operational objectives are the main, compulsory teaching/learning targets and they are specifically evaluated for certification. There are two kinds of operational objectives: behavioural and situational.

- **A behavioural objective** is a relatively closed objective that describes the actions and results expected of the student by the end of a learning step. Evaluation is based on expected results.
- **A situational objective** is a relatively open-ended objective that outlines the major phases of a learning situation. It allows for output and results to vary from one student to another. Evaluation is based on the student's participation in the activities of the learning context.

5.2 HOW TO READ AN OPERATIONAL OBJECTIVE

A. How to Read a Behavioural Objective

Behavioural objectives consist of five components. The first two provide an overview of the objective:

- The **expected behaviour** states a competency in terms of the general behaviour that the students are expected to have acquired by the end of the module.
- The **conditions for performance evaluation** define what is necessary or permissible to the students during evaluation designed to verify whether or not they have attained the objective. This means that the conditions for evaluation are the same wherever and whenever the program is taught.

The last three components ensure that the objective is understood clearly and unequivocally:

- The **specifications of the expected behaviour** describe the essential elements of the competency in terms of specific behaviours.
- The **specific performance criteria** define the requirements for each of the specifications of behaviour. They ensure a more enlightened decision on the attainment of the objective.
- The **field of application** defines the limits of the objective, *where necessary*. It indicates cases where the objective applies to more than one task, occupation or field.

B. How to Read a Situational Objective

Situational objectives consist of six components:

- The **expected outcome** states a competency as an aim to be pursued throughout the course.

- The **specifications** outline the essential aspects of the competency and ensure a better understanding of the expected outcome.

- The **learning context** provides an outline of the learning situation designed to help the students develop the required competencies. It is normally divided into three phases of learning:
  - information
  - performance, practice or involvement
  - synthesis, integration and self-evaluation

- The **instructional guidelines** provide suggested ways and means of teaching the course to ensure that learning takes place. These guidelines may include general principles or specific procedures.

- The **participation criteria** describe the requirements the students must fulfil. They focus on how the students take part in the activities rather than on the results obtained. Participation criteria are normally provided for each phase of the learning context.

- The **field of application** defines the limits of the objective, *where necessary*. It indicates cases where the objective applies to more than one task, occupation or field.

Note: In this program, the objectives are also accompanied by suggestions concerning the instructional approach and related content applicable to the specifications of the expected behaviour, in the case of a behavioural objective, or to the phases of the learning context, in the case of a situational objective. Since this information was used to determine the competencies, it might be useful for those involved in the implementation of the program. It goes without saying that the suggestions and related content are provided for informational purposes only.

PART II

MODULE 1: THE TRADE AND THE TRAINING PROCESS		CODE: 872 011 15 HOURS
HARMONIZATION: **This module is equivalent to Module 1 of *Numerical Control Machine Tool Operation* (AVS).**		
Expected Outcome	**Instructional Guidelines**	**Suggested Approach**
Determine their suitability for the trade and the training process. *Specifications*: Be familiar with the nature of the trade. Understand the training plan. Confirm their career choice. Be aware of the impact of new management approaches in Québec businesses.	• Create a climate that helps the students to enter the job market. • Encourage the students to engage in discussions and express themselves. • Help the students acquire an accurate perception of the trade, especially with respect to the new types of work organization. • Provide the students with the means to assess their career choice honestly and objectively. • Organize field trips to companies that are representative of the work environment, visits to exhibitions, meetings with trade specialists, conferences, etc. • Make available to the students a selection of relevant literature. • Provide the students with an outline for their report and help them produce their documents.	• An observation checklist would make it easier to follow the students' progress in developing this competency.

Learning Context	Participation Criteria	Suggested Related Content
PHASE 1: **Information on the Trade**	- Gather information on most of the topics to be dealt with. - Express their views on the trade at a group meeting, relating them to the information they have gathered.	
• Learning about the types of companies that employ machinists and about the different types of work organization.		• Size of the company, sector of economic activity, type of clientele, type of production, manufacturing processes and use of new types of equipment • Types of management and work organization, in accordance with current standards • Other
• Describing factory production and the different jobs involved.		• Stages in the production process: - research into new processes - design and drawing of products - design of transformation methods or processes - optimization of production - training of personnel - planning - performance of transformation or manufacturing processes - inspection (planning and testing) - planning and performance of equipment maintenance - application of management techniques • Distribution of stages among jobs involved

Learning Context	Participation Criteria	Suggested Related Content
• Learning about the nature and requirements of the job.		• Reference to Chapter 1 of the job situation analysis report: work environment, job prospects, salaries, opportunities for transfer and advancement, selection of candidates, etc. • Position of machining in the company's organizational chart • Specific requirements of the job • Determination of duties and responsibilities of workers • Their role in various work teams • Participation in the optimization of production • Other
• Examining trade-related tasks and operations.		• Reference to Chapter 2 of the job situation analysis report
• Examining the skills and behaviours needed to practise the trade.		• Reference to Chapter 3 of the job situation analysis report

Learning Context	Participation Criteria	Suggested Related Content
• Presenting the information gathered and discussing their views on the trade (i.e. advantages, disadvantages, requirements) at a group meeting.		• Rules governing group discussion • Attitudes and behaviours: respect, politeness, attentiveness • Knowledge, skills and aptitudes required to practise the trade • Definition of their preferences and interest with respect to machining techniques
PHASE 2: **Information on Training and Participation in the Training Process**	- Study carefully the written material provided. - Express their views on the program of study at a group meeting.	
• Learning about the program of study and the training process.		• Examination of the program of study, especially the synoptic table, the program training goals and general objectives, and the objectives and standards • Information on evaluation, certification of studies and course structure
• Discussing the relevance of the program given the work situation.		• Comparisons between the job situation analysis report and the competencies included in the program
• Sharing their initial reactions to the specialized trade and the training program.		• Verification of opportunities afforded by technological development, new types of work organization, new materials, etc.
• Learning about the concept of techno-watch and further training.		• Upgrading to keep pace with technological development • Adaptation to new management approaches • Career progress • Change of career direction • Development of trade-related knowledge, personal culture, etc. • Examination of opportunities afforded by further training

Learning Context	Participation Criteria	Suggested Related Content
PHASE 3: **Evaluation and Confirmation of Their Career Choice** • Producing a report in which they: - state their preferences, aptitudes and interest with respect to the trade - assess their career choice by comparing the different aspects and requirements of the trade with their own preferences, aptitudes and interests	- Write a report that: - sums up their preferences, aptitudes and interests - explains clearly how they arrived at their career choice	• Parts of a report • Items to include • Production of the report using the outline provided by the instructor • Neatness, clarity and concision

MODULE 2: MATHEMATICS RELATED TO CONVENTIONAL MACHINING CODE: 872 024 60 HOURS		
Expected Behaviour	**Conditions for Performance Evaluation**	**Suggested Approach**
Solve mathematical problems related to conventional machining.	• Given drawings of parts to be machined in the metric and imperial systems of measurement • Given written instructions • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - mathematical formulae • Using a scientific calculator	• Have the students solve problems in both the metric and imperial systems of measurement. • Demand serious, careful work. • Provide students with individualized support. • Review the basic operations, the rule of three and the transformation of formulae. Then, provide the students with drawings of parts to be machined and have them do calculations related to the manufacture and inspection of parts to be made in the shop. • Integrate mathematics into all machining projects by distributing the hours of instruction in this subject throughout much of the first year of training. • Integrate the learning in this module into the students' work on their machining projects.

Specifications	Performance Criteria	Suggested Related Content
1. Do calculations related to machining parameters.	1.1 Accurate identification of information in tables related to machining parameters 1.2 Proper use of nomographs 1.3 Proper choice of formulae 1.4 Proper application of formulae 1.5 Accurate calculations	• Method of consulting tables and nomographs • Items to locate in reference tables and technical manuals: machining parameters, formulae related to machining and values related to machining and quality control • Machining parameters: cutting speed, rpm, feed rate and depth of cut • Definition of elements of formulae • Basic formulae related to the calculation of machining parameters • Calculation of surfaces and volumes • Volume of material removed per minute • Method of calculating using the rule of three • Application and transformation of formulae • Suggested enrichment activity: Have the students do calculations related to pulley and gear systems. • Decimals and fractions • Metric and imperial systems of measurement • Use of a scientific calculator

Specifications	Performance Criteria	Suggested Related Content
2. Do calculations related to conventional machining operations.	2.1 Determination of calculations required for the job: - dimensions - angles - polar and rectangular coordinates 2.2 Accurate identification, in drawings and manuals, of the information needed for the calculations 2.3 Choice of effective problem-solving process 2.4 Proper application of: - formulae - Pythagorean theorem - trigonometric functions - law of sines and cosines 2.5 Accurate transformation of formulae 2.6 Accurate results	• Items to locate in the drawings: - dimensions - tolerance limits, in accordance with international and American standards - annotations - title block - other • Method of consulting tables • Decimals and fractions • Simple geometric analysis • Solution of right-angle triangles: Pythagorean theorem and trigonometric functions • Solution of other types of triangles: law of sines and cosines • Technique of solving a triangle by breaking it down into right-angle triangles • Application and transformation of formulae • Summary table of solution of right-angle and other types of triangles • Calculation of polar and rectangular coordinates • Conversion of polar coordinates into rectangular coordinates and vice versa • Solution of problems requiring analysis and reasoning • Metric and imperial systems of measurement • Use of a scientific calculator
3. Convert measurements from the metric to the imperial system and vice versa.	3.1 Proper use of conversion tables 3.2 Proper choice of formulae 3.3 Proper application of conversion formulae 3.4 Accurate calculations	• Decimals and fractions • Units of length, weight and volume • Conversion factors and tables • Metric and imperial systems of measurement • Use of a scientific calculator

MODULE 3: INTERPRETING TECHNICAL DRAWINGS		**CODE: 872 035 75 HOURS**
HARMONIZATION: **This module is equivalent to Module 3 of *Industrial Drafting* (DVS) and competency 012F of *Mechanical Engineering Technology* (DEC).**		
Expected Behaviour	**Conditions for Performance Evaluation**	**Suggested Approach**
Interpret technical drawings.	• Given: - detail and assembly drawings in metric and imperial units of measurement - drawings illustrating an assembly method or other illustrations - instructions - technical documentation - tables - drafting standards	• Select drawings that will be used for the specific competencies. • Help the students develop spatial perception by having them read examples of descriptive geometry. • Keep assembly drawings for the end of the module. • Research related to the manufacture of parts should be integrated into the relevant specific competencies. • Accustom the students to consulting drawings that use English and French terminology.

Specifications	Performance Criteria	Suggested Related Content
1. Visualize a complete part.	1.1 Accurate differentiation among the types of projections: - American and European orthographic projections - axonometric projections 1.2 Proper identification of views and sections 1.3 Accurate interpretation of lines and hatching lines 1.4 Accurate identification of part on assembly drawing 1.5 Accurate observations of the shape of the part and its position in the whole 1.6 Proper drawing of symmetry of illustrated part 1.7 Relevant association of lines, points and surfaces in different views	• Arrangement of views • Perspectives • Projection plane • Contour lines • Visible and hidden lines • Centre lines • Top view • Front view • Side view (right and left) • Full, partial, half and broken-out sections • Auxiliary views: depth dimensions, front view, top view • Revolved and removed sections • Standard hatching lines for the materials used • Sectional plan • Break line • Standards and conventions • Cut-away view of threads • Principles underlying projection • Reference plane

Specifications	Performance Criteria	Suggested Related Content
2. Interpret the dimensioning.	2.1 Thorough identification of information needed for the job: - dimensions - dimensions with tolerances - form and positioning tolerances, and backlash - nomenclature of threads - fit tolerances 2.2 Determination of value of: - dimensions - dimensions with tolerances - form tolerances - positioning tolerances - backlash - size and location dimensions 2.3 Relevant associations between the dimensions and the surfaces of various views	• Extension line • Dimension line • Standardized dimensioning • Dimensions with tolerances: reference dimension, basic dimension, minimum dimension, maximum dimension and maximum and minimum limit • Form tolerances: straightness, flatness, circularity and cylindricity • Positioning tolerances: location, parallelism, squareness, coaxiality, symmetry and angularity • Single and double backlash • Standardized adjustments: - clearance fit - transition fit - interference fit • Symbols • Modifying symbols • Reference surfaces
3. Find complementary information in technical drawings.	3.1 Proper identification of information in: - title block - list of terms used - annotations 3.2 Thorough identification of information needed 3.3 Accurate interpretation of symbols, codes and abbreviations	• Scale, codification of materials, symbols, abbreviations, etc. • Tolerances, surface conditions, roughness index symbols, etc. • Standards and conventions

Specifications	Performance Criteria	Suggested Related Content
4. Determine the function of the components of an assembly.	4.1 Thorough identification of the components of an assembly in an assembly drawing 4.2 Recognition of the characteristics of the components 4.3 Recognition of the function of each component of the assembly and its relationship with the other components	• Functions: permanent or temporary installation, fastening, transformation of motion, power transmission, leak tightness, stops, etc. • English and French terminology • Diagrammatic view • Parts • Fasteners • Machine parts • Seals • Bushings and bearings • Principles underlying assembly • Principles underlying power transmission • Principles underlying the transformation of motion • Standardized phantom lines

MODULE 4: HEALTH AND SAFETY		CODE: 872 041 15 HOURS
Expected Behaviour	**Conditions for Performance Evaluation**	**Suggested Approach**
Avoid occupational health and safety risks.	• Working in a mechanical manufacturing shop • Given work situations presenting health and safety risks • Using relevant documentation	• It is important that the students understand that the same health and safety measures they follow at school apply in the workplace.

Specifications	Performance Criteria	Suggested Related Content
1. Identify the aspects of health and safety legislation that apply to work in mechanical manufacturing shops.	1.1 Proper identification of information 1.2 Relevant associations made between sections of the law and regulations and activities performed in the workplace 1.3 Recognition of the rights and obligations of the parties involved	• Regulation respecting industrial and commercial establishments • Regulation respecting the quality of the work environment • Regulation respecting information on controlled products • Rights and responsibilities of employers and workers
2. Recognize the risks present in a machine shop and their effects on health and safety.	2.1 Recognition of the main causes of stress 2.2 Recognition of the risks inherent in the trade 2.3 Accurate interpretation of WHMIS data sheets 2.4 Accurate identification of the effects of each type of stress and risk on health and safety	• Reference to table entitled *Éléments de sécurité au travail liés à la profession de machiniste*, an appendix of the job situation analysis report • Resources: CSST, unions, Commission des normes du travail, joint committees, etc.
3. Determine means of preventing accidents.	3.1 Choice of relevant methods for: - setting up the shop and the work station - performing trade-related operations - handling loads - using hazardous materials 3.2 Proper choice of personal safety gear	• Reference to table entitled *Éléments de sécurité au travail liés à la profession de machiniste*, an appendix of the job situation analysis report

Specifications	Performance Criteria	Suggested Related Content
4. Determine what to do in an emergency situation.	4.1 Choice of appropriate strategy 4.2 Recognition of the seriousness of the situation on the basis of signs and symptoms 4.3 Judgment of the need to intervene or ask for help 4.4 Determination of the basic first aid required	• Things to be done or behaviour to be adopted in the case of malaise, injuries, burns, falls, poisoning, fumes, fire, etc. • Collection of information (symptoms, identification of victim, Medicalert bracelet, pregnancy, etc.) • Recognition of the seriousness of the situation • Limits • First-aid kit, blankets, tourniquets, stretcher, extinguishers, proximity of a telephone, important telephone numbers, etc. • Familiarization with basic first-aid techniques
5. Convey information on health and safety to colleagues.	5.1 Appropriate choice of information 5.2 Proper choice of means of conveying the information 5.3 Clarity and coherence of information conveyed 5.4 Persuasive message	• Verbal and written communication • Newsletters, videos, conferences, information meetings, Internet, etc.

MODULE 5: TAKING AND INTERPRETING MEASUREMENTS		**CODE: 872 054 60 HOURS**
HARMONIZATION: **This module is equivalent to Module 12 of *Industrial Drafting* (DVS) and competency 012P of *Mechanical Engineering Technology* (DEC).**		
Expected Behaviour	**Conditions for Performance Evaluation**	**Suggested Approach**
Take and interpret measurements.	• Given: - objects to be measured - assembly or detail drawings in metric and imperial units of measurement - measuring instruments and devices - a scientific calculator - inspection records - cleaning products and lubricants • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - conversion tables	• Return to this competency throughout the program in order to establish links with the quality control of parts in the modules related to machining processes. • Use instruments graduated in the metric and imperial systems of measurement. • Demand serious, careful work. • Emphasize the importance of quality control. • Inform the students of their responsibilities in an industry concerned with total quality.

Specifications	Performance Criteria	Suggested Related Content
1. Plan the work.	1.1 Understanding of the context and characteristics of the object to be measured 1.2 Accurate interpretation of the information contained in the drawings: - dimensions - tolerances - instructions 1.3 Appropriate choice of measuring instruments and devices 1.4 Proper positioning of part and choice of fastenings for the part to be measured 1.5 Organized arrangement of instruments and devices	• Graduated measuring instruments: rulers, vernier callipers, micrometers, dial gauges, touch-sensing probes, protractors, bore gauges, etc. • Non-graduated measuring instruments: dividers, square, marking gauge, telescope gauge, etc. • Callipers, jigs and parallels: threads, angles, radii, diameter, taper, roughness index, etc. • Testing instruments: sine bar, sine plate, surface plates, angle plate, parallels, jack, V block, three-wire method, balls, etc. • Testing apparatus: optical comparator, hardness tester, roughness tester and numerical measuring instruments
2. Prepare the measuring instruments and devices, as well as the part to be measured.	2.1 Precise inspection of instruments and devices 2.2 Accurate calibration and adjustment of measuring instruments and devices 2.3 Proper preparation of part 2.4 Cleanliness of work area	• Detection of defects • Neatness • Calibration and adjustment techniques • Manufacturer's standards • Cleaning, deburring, handling, mounting and fastening of part • Test temperature (thermal expansion)
3. Measure parts of different shapes.	3.1 Accurate calculation of information needed for measurement 3.2 Proper use of measuring instruments and devices 3.3 Accurate reading of dimensional and geometric measurements 3.4 Accurate conversion of dimensions in the metric and imperial systems of measurement 3.5 Accurate interpretation of measurements 3.6 Accurate recording of results	• Calculations associated with measurement: offset dimensions, height of gauge blocks, coordinates and conversions • Methods of using instruments and devices: direct reading, transfer of measurements from one instrument to the other and go, no-go gauges • Interpretation of measurements • Inspection records

Specifications	Performance Criteria	Suggested Related Content
4. Inspect the physical characteristics of parts.	4.1 Proper use of measuring instruments and devices 4.2 Accurate readings 4.3 Observance of technique for converting scales 4.4 Accurate recording of results	• Techniques • Optical comparators • Roughness and hardness testers • Hardness scales: Rockwell, Brinell, etc. • Conversion tables for hardness scales • Inches and centimetres • Inspection records
5. Sketch the part.	5.1 Proper choice of views 5.2 Accurate and proportional representation of part 5.3 Accurate recording of dimensioning and relevant information	
6. Perform regular maintenance on measuring instruments and devices.	6.1 Careful cleaning of instruments and devices 6.2 Lubrication of instruments and devices at the appropriate points 6.3 Proper storage of instruments and devices	• Simple assembly and disassembly of components • Products and accessories • Cleaning methods • Lubrication points • Frequency of lubrication • Types of lubricants • Cleanliness • Protection against rust, dust, products, shock, etc.

MODULE 6: SHOP WORK		CODE: 872 066 90 HOURS
Expected Behaviour	**Conditions for Performance Evaluation**	**Suggested Approach**
Do shop work.	• Given: - drawings of simple parts in metric or imperial units of measurement - instructions - bar stock with a high machinability rating - drills and saws - conventional, electric or air deburring tools and equipment - high-speed steel or carbide tools - abrasives - drill jigs - testing and layout instruments and devices - products - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues • Following health and safety rules	• Encourage the students to use new types of cutting tools and abrasives. • At the beginning of the module, provide the students with process sheets and have them interpret them and then gradually design their own simple process sheets. • Provide the students with drawings without fit tolerances, appropriate to their level of skill. • Limit the use of files to deburring or finishing operations. • Encourage the students to use electric and air tools to remove excess material.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings, process sheets and manuals, the information needed for the job.	1.1 Accurate identification of: - dimensions - dimensional, form and positioning tolerances - characteristics of surface finishes - type of materials - sequence of operations - the necessary tools and installation methods - machining parameters 1.2 Accurate interpretation of manufacturing standards related to machine parts 1.3 Proper identification of information in the list of terms used, the title block and the annotations 1.4 Accurate identification of reference surfaces 1.5 Accurate interpretation of: - symbols, codes and abbreviations - English and French technical terminology - verbal and written instructions	• Detail drawings in metric and imperial units of measurement • Symbols • Codes • Materials • Dimensions

Specifications	Performance Criteria	Suggested Related Content
2. Lay out workpieces.	2.1 Proper inspection of: - the workpiece and its conformity with the drawing - the surface plate - the layout instruments - the mounting accessories 2.2 Appropriate corrections made 2.3 Careful preparation of surfaces 2.4 Proper positioning of workpiece 2.5 Observance of techniques for laying out: - parallel - angular - curvilinear 2.6 Layout in conformity with drawing and operations to be performed 2.7 Definitive layout of lines using a prick punch	• Characteristics of castings • Deburring techniques • Layout instruments • Mounting and fastening accessories • Application of layout dye • Mounting methods • Cleaning products and their use • Layout methods • Techniques for sharpening scribers and dividers
3. Mount the workpiece.	3.1 Visual and manual inspection of mounting equipment and accessories 3.2 Appropriate corrections made 3.3 Installation of accessories in accordance with the mounting method: - vice - jaw covers - angle plates - rotary table 3.4 Proper positioning and alignment of workpiece 3.5 Safe installation of workpiece	• Characteristics of an appropriate installation • Method of handling workpiece and mounting accessories • Condition and maintenance of accessories • Alignment of workpiece • Method of mounting accessories • Orientation of workpiece • Method of clamping and effect on workpiece

Specifications	Performance Criteria	Suggested Related Content
4. Prepare the work station.	4.1 Visual and manual inspection of equipment, abrasives and accessories 4.2 Appropriate corrections made 4.3 Adjustments in conformity with process sheet: - feed rate - rpm and direction of rotation - security device 4.4 Organized arrangement of instruments 4.5 Observance of health and safety rules	• Inspection of cut • Sharpening and replacement of tips, blades and abrasives, and dressing of grinding wheel • Adjustment of tool height • Orientation of tool • Proper mounting of tool • Verification of availability of testing, calibration and adjustment instruments
5. Perform the following operations: - deburring - sanding - polishing - sawing - drilling - sharpening - boring - counterboring - chamfering - tapping - facing - broaching	5.1 Conformity with process sheet 5.2 Observance of roughing and finishing techniques in accordance with the type of operation performed 5.3 Safe use of tools and equipment 5.4 Detection of machining problems 5.5 Appropriate corrections made 5.6 Proper use of cutting fluids and coolants 5.7 Machining in conformity with drawings 5.8 Careful deburring and cleaning of part	• Kinematic chains of drills and saws • Start-up of equipment • Movement of parts • Increments • Effects of cut on workpiece: thermal expansion and deformation • Method of using cutting fluids and coolants • Techniques for performing the different operations, including roughing and finishing • Inspection during the machining process: dimensional, form and positioning tolerances, and roughness index • Deburring techniques • Health and safety rules
6. Control the quality of the machined part.	6.1 Accurate identification of dimensions 6.2 Observance of dimensional, form and positioning tolerances 6.3 Proper control of surface finishes 6.4 Proper presentation of results in reports 6.5 Careful cleaning and storage of measuring devices and instruments	• Inspection of linear and angular dimensions, form and positioning tolerances, and surfaces • Direct and indirect measuring instruments • Other necessary inspection devices or instruments • Calibration and adjustment • Roughness tester • Concepts of self-inspection

Specifications	Performance Criteria	Suggested Related Content
7. Perform regular maintenance on machines, devices, accessories and tools.	7.1 Proper cleaning and storage of the machine tool, devices, tools and accessories, and proper cleaning of work area 7.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 7.3 Appropriate corrections made 7.4 Lubrication by hand at the appropriate points 7.5 Appropriate reporting of abnormalities 7.6 Observance of health and safety rules 7.7 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Lubrication methods • Types of lubricants: soluble oils, lubricating oils, hydraulic oils and greases • Lubrication points • Treatment or replacement of substandard soluble oils • Health risks associated with contaminated coolants • Disposal of used oil • Detection of abnormal vibrations and noises • Technique for welding band saw blades • Criteria related to cleanliness

MODULE 7: MATERIALS AND PROCESSES		CODE: 872 072 30 HOURS
Expected Behaviour	**Conditions for Performance Evaluation**	**Suggested Approach**
Interpret technical information related to materials and manufacturing processes.	• Related to metallic, non-metallic and composite materials • Using technical documentation in English and French: - technical drawings - reference manuals relating to materials, such as *Machinery's Handbook* - catalogues of ferrous products - data sheets, tables and standards, such as *ANSI*, *SAE*, *ASTM* and *CSA*	• Visit to a workplace suggested • Provide the students with samples of the materials studied. • Perform demonstrations or tests of heat and surface treatments. • Study in more detail the materials related to the projects to be done.

Specifications	Performance Criteria	Suggested Related Content
1. Describe materials.	1.1 Proper identification of information in drawings and documentation 1.2 Accurate interpretation of symbols and notations in drawings 1.3 Accurate interpretation of Canadian, American and international material identification codes 1.4 Appropriate links between the chemical composition of the materials and their physical properties 1.5 Appropriate identification of the dangers associated with the handling of certain materials 1.6 Recognition of the behaviour of materials 1.7 Appropriate association of materials with their applications in different manufacturing sectors	• Ferrous metals, non-ferrous metals, plastics, nylons, composites, etc. • Properties: brittleness, ductility, malleability, hardenability and machinability • Resistance to corrosion, wear and heat • Limits of use • Risk of toxic fumes • Flammability • Automobile sector, aerospace sector, marine sector, pharmaceutical sector, etc.
2. Differentiate among the processing methods presented in the documentation.	2.1 Accurate distinction between the first and second levels of processing of materials 2.2 Proper differentiation among: - the main heat treatments - the main surface treatments 2.3 Appropriate links between processing methods and their effects on the properties of the materials 2.4 Appropriate association between processing methods and the surface finishes specified in the technical drawings	• First level of processing: lamination, roll bending and extrusion • Second level of processing: moulding, shaping and machining • Quenching and annealing • Anodizing, chromating and case hardening • Deformation, elongation, hardness, machinability and surface finish
3. Interpret information related to the dimensions of different types of stock.	3.1 Accurate distinction among the commercial types of stock 3.2 Appropriate identification of dimensions 3.3 Accurate interpretation of dimensional tolerances	• Bars, tubes, profiles, sheets and castings • Catalogues • Standards

MODULE 8: SKETCHES		**CODE: 872 083 45 HOURS**
HARMONIZATION: **This module is equivalent to competency 012G of *Mechanical Engineering Technology* (DEC).**		
Expected Behaviour	**Conditions for Performance Evaluation**	**Suggested Approach**
Sketch objects.	• Given: - detail and assembly drawings in metric and imperial units of measurement - American and European orthographic projections - axonometric projections - real parts to be sketched - plotting and isometric paper - measuring instruments - different reference materials, such as tables, nomographs and technical manuals - a scientific calculator • Conformity with standards • Drawing freehand or using basic instruments	• Point out the importance of sketching in the industry. • Have the students sketch using both the metric and imperial systems of measurement. • Help the students develop freehand drawing skills or the ability to draw using only basic instruments such as a ruler, dividers, a square and plotting paper. • Help the students develop spatial perception using different methods. • Demand serious, careful work. • Provide students with individualized support. • To help integrate basic concepts related to sketching and drawing, this competency can be presented concurrently with the competency *Interpret technical drawings.* Also, conventional drawing may be used as a supplementary learning activity.

Specifications	Performance Criteria	Suggested Related Content
1. Sketch orthographic projections.	1.1 Conformity with standards and conventions related to: - lines - American projections - European projections 1.2 Accurate identification of dimensions of part to be sketched 1.3 Determination of the number and types of views 1.4 Observance of proportions and shapes of the object to be sketched 1.5 Proper application of sketching techniques 1.6 Accurate, clean lines	• Types of lines: fine, medium and heavy • Types of conventional lines: - construction - visible features - hidden features - centre - cutting - broken - dimension - extension • Techniques for drawing lines: - horizontal - vertical - skew - curved • Use of basic instruments: pencil, rulers (metric and imperial systems of measurement), plotting paper, etc. • Principle of orthographic projection according to the American and European methods • Number and names of views • Arrangement of views • Relationships among the different views • Choice of number and types of views in accordance with: - shape of part - complexity of part - other • Surface intersections and tangents • Scale • Representation of: - holes - fillets and rounds - edges and phantom lines - symmetrical parts - threaded parts • Method of measuring a part to be sketched • Method of examining an assembly drawing in order to sketch an orthographic projection

Specifications	Performance Criteria	Suggested Related Content
2. Sketch axonometric projections.	2.1 Conformity with standards and conventions related to: - lines - isometric drawings - oblique projections 2.2 Accurate identification of dimensions of the part to be sketched 2.3 Observance of proportions 2.4 Observance of shapes of the object to be sketched using skewed lines and ellipses 2.5 Observance of sketching techniques 2.6 Accurate, neat sketch	• Method of identifying the dimensions of a part to be sketched • Types of axonometric projections: - isometric - oblique: cabinet • Methods of drawing an axonometric projection • Use of isometric paper • Method of examining an assembly drawing in order to sketch an axonometric projection
3. Sketch sectional, auxiliary and partial views.	3.1 Conformity with standards and conventions related to: - lines - hatching lines - sections 3.2 Appropriate choice of section 3.3 Observance of proportions and shapes of the object to be sketched 3.4 Observance of sketching techniques 3.5 Accurate, neat sketch	• Representation of hidden shapes and parts • Importance of an appropriate section • Methods of producing sections • Types of sections: - full - broken-out with parallel planes - broken-out with intersecting planes - half - partial - removed - revolved • Section of a rib • Broken-out views • Types of hatching lines, in accordance with the materials • Sections in isometric and oblique perspective • Purpose and method of sketching an auxiliary view • Auxiliary sections • Purpose and method of sketching a partial view

Specifications	Performance Criteria	Suggested Related Content
4. Dimension the sketch.	4.1 Conformity with standards and conventions related to: - extension lines - dimension lines - conventional and absolute dimensioning - notation of dimensions in axonometric projections 4.2 Proper arrangement of dimensions 4.3 Dimensioning adapted to manufacturing 4.4 Appropriate tolerance limits and surface finishes according to the role of the part or one of its components 4.5 Proper use of symbols 4.6 Proper use of metric and imperial systems of measurement 4.7 Neat, clear dimensioning	• Techniques for noting dimensions: - extension lines - dimension lines - reference lines - arrowheads - position of dimensions - orientation of dimensions - other • Basic principles of dimensioning • Conventional and absolute dimensioning • Standardized symbols for dimensioning • Dimensions with tolerances: - basic dimension - average dimension - minimum dimension - maximum dimension - upper and lower limits • Size and location dimensions • Dimensioning of holes • Dimensioning of different views in orthographic projection • Dimensioning of drawings in isometric perspective • Symbols for the roughness index and shaping methods • Standardized classes of fit • Method of examining an assembly drawing in order to produce a dimensioned sketch • Metric and imperial systems of measurement

Specifications	Performance Criteria	Suggested Related Content
5. Write the annotations and information in the title block.	5.1 Complete information 5.2 Clarity and concision of notes 5.3 Annotations adapted to manufacturing 5.4 Proper use of the metric and imperial systems of measurement 5.5 Neatness of annotations and information in the title block	• Leaders • Method of writing annotations in accordance with the operations to be performed • General and specific notes • Information in the title block • Metric and imperial systems of measurement

MODULE 9: EXTERNAL CYLINDRICAL TURNING **CODE: 872 096** **90 HOURS**

Harmonization:
The content of Modules 9, 10 and 12 of this program is equivalent to competency 012Q of *Mechanical Engineering Technology* (DEC).
The content of Modules 9, 10, 11, 12, 13 and 17 of this program corresponds to competency 011S of *Aircraft Manufacturing Technology* (DEC).

Expected Behaviour	Conditions for Performance Evaluation	Suggested Approach
Perform external cylindrical turning operations.	• Given: - drawings of simple parts to be machined in metric or imperial units of measurement - instructions - bar stock with a high machinability rating - conventional horizontal lathes and their accessories - conventional carbide and new types of high speed steel and high performance tools - testing instruments and apparatus - products - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues • Following health and safety rules	• Encourage the students to use new types of cutting tools. • At the beginning of the module, provide the students with process sheets and have them interpret them and then gradually design their own simple process sheets. • Provide the students with drawings without fit tolerances appropriate to their level of skill.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings and manuals, the information needed for the job.	1.1 Accurate identification of: - dimensions - dimensional, form and positioning tolerances, and backlash - characteristics of surface finishes - type of materials 1.2 Accurate interpretation of manufacturing standards related to machine parts 1.3 Proper identification of information in the list of terms used, the title block and the annotations 1.4 Accurate identification of reference surfaces 1.5 Accurate interpretation of: - symbols, codes and abbreviations - English and French terminology - verbal and written instructions	• Detail drawings in metric and imperial units of measurement • Symbols • Codes • Materials • Dimensioning

Specifications	Performance Criteria	Suggested Related Content
2. Develop the process sheet.	2.1 Determination of logical sequence of machining operations 2.2 Choice of lathe in accordance with: - its capacity - the turning operations required 2.3 Choice of mounting methods in accordance with: - the material to be machined - the turning operations required - the machining precision required 2.4 Proper identification of support and clamping points 2.5 Choice of cutting tools and mounting methods in accordance with: - their machining capacity - the material to be machined - the turning operations required - the capacity of the lathe - the surface finishes - the optimization of the process 2.6 Proper choice of testing instruments and apparatus 2.7 Verification of availability of machine, accessories, tools, measuring instruments and testing apparatus 2.8 Determination of: - machining parameters - travel coordinates 2.9 Careful sketch of workpiece in machining position	• Routines, subroutines and operations • Productivity and quality resulting from the sequence of operations • Components of the lathe • Condition and capacity of the lathe: length between centres, turning diameter, accessories, rpm, feed and increment • Isostasy • Characteristics of a proper installation • Safety rules applicable to installation • Cutting tools: material and grade, physical characteristics and heat effects of cut • Geometry of cutting tools and terminology: angles, radii, chip breaker, shapes and sizes • Calculation of cutting parameters: rpm, feed rate and depth of cut • Use of tables and nomographs • Travel coordinates: machining allowance and polar coordinates • Measuring instruments in metric and imperial units of measurement: rulers, vernier calliper, micrometer callipers, dial gauge, protractor, dividers, etc. • Testing apparatus: roughness tester, parallels, gauge blocks, V blocks, sine bar, etc. • Isostatic symbols (support, clamping, etc.), dimensioning and highlighting of surfaces to be machined

Specifications	Performance Criteria	Suggested Related Content
3. Mount the workpiece on the lathe.	3.1 Visual and manual inspection of lathe and mounting accessories 3.2 Appropriate corrections made 3.3 Installation of accessories in accordance with the mounting method: - three-jaw chucks - four-jaw chucks - flexible collets - stationary and revolving centres 3.4 Proper positioning and alignment of workpiece 3.5 Safe installation of workpiece on lathe	• Characteristics of a proper installation • Handling of workpiece and mounting accessories • Condition and maintenance of accessories • Alignment of tailstock • Method of mounting accessories • Position and orientation of workpiece • Clamping technique and effect on workpiece
4. Prepare the lathe and the work station.	4.1 Visual and manual inspection of cutting tools, measuring instruments and accessories 4.2 Appropriate corrections made 4.3 Proper positioning and mounting of cutting tools 4.4 Adjustments in conformity with process sheet: - feed rate - rpm - compound rest 4.5 Organized arrangement of instruments 4.6 Observance of health and safety rules	• Inspection of cut • Sharpening and replacement of tip • Adjustment of tool height • Orientation of tool • Proper mounting of tool • Verification of availability of testing, calibration and adjustment instruments

Specifications	Performance Criteria	Suggested Related Content
5. Perform external cylindrical turning operations, such as: - drilling (centre hole) - facing - parallel turning - axial and radial grooving - chamfering - knurling - parting off	5.1 Conformity with process sheet 5.2 Observance of roughing and finishing techniques in accordance with the type of operation performed 5.3 Safe use of lathe 5.4 Accurate identification of machining problems 5.5 Appropriate corrections made to: - the machining process - the process sheet 5.6 Confirmation of validity of corrections with the appropriate person at the appropriate time 5.7 Proper use of cutting fluids and coolants 5.8 Machining in conformity with drawings 5.9 Careful deburring and cleaning of part	• Kinematic chain of lathe • Start-up • Movement of carriages • Increments • Effects of cut on workpiece: thermal expansion and deformation • Method of using cutting fluids and coolants • Techniques for performing the different operations, including roughing and finishing • Inspection during the machining process: dimensional, form and positioning tolerances, and roughness index • Deburring techniques • Health and safety rules
6. Control the quality of the machined part.	6.1 Accurate identification of dimensions 6.2 Observance of dimensional, form and positioning tolerances 6.3 Proper control of surface finishes 6.4 Proper presentation of results in reports 6.5 Careful cleaning and storage of measuring devices and instruments	• Inspection of linear and angular dimensions, form and positioning tolerances, and surfaces • Concepts of self-inspection

Specifications	Performance Criteria	Suggested Related Content
7. Perform daily maintenance on the lathe, accessories and cutting tools.	7.1 Proper cleaning and storage of the machine tool, tools and accessories, and proper cleaning of work area 7.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 7.3 Appropriate corrections made 7.4 Lubrication by hand at the appropriate points 7.5 Appropriate reporting of abnormalities 7.6 Observance of health and safety rules 7.7 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Lubrication methods • Types of lubricants: soluble oils, lubricating oils, hydraulic oils and greases • Lubrication points • Treatment or replacement of substandard soluble oils • Health risks associated with contaminated coolants • Disposal of used oil • Detection of abnormal vibrations and noises

MODULE 10: BORING **CODE: 872 105 75 HOURS**

Harmonization:
The content of Modules 9, 10 and 12 of this program is equivalent to competency 012Q of *Mechanical Engineering Technology* (DEC).
The content of Modules 9, 10, 11, 12, 13 and 17 of this program correspond to competency 011S of *Aircraft Manufacturing Technology* (DEC).

Expected Behaviour	Conditions for Performance Evaluation	Suggested Approach
Perform boring operations.	• Given: - drawings of simple parts to be machined in metric or imperial units of measurement - instructions - bar stock with a high machinability rating - conventional horizontal boring mills and their accessories - conventional carbide and new types of high speed steel and high performance tools - testing instruments and apparatus - products - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues • Following health and safety rules	• Encourage the students to use new types of cutting tools. • At the beginning of the module, provide the students with process sheets and have them interpret them and then gradually design their own simple process sheets. • Provide the students with drawings without fit tolerances appropriate to their level of skill.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings and manuals, the information needed for the job.	1.1 Accurate identification of: - dimensions - dimensional, form and positioning tolerances, and backlash - characteristics of surface finishes - type of materials 1.2 Accurate interpretation of manufacturing standards related to machine parts 1.3 Proper identification of information in the list of terms used, the title block and the annotations 1.4 Accurate identification of reference surfaces 1.5 Accurate interpretation of: - symbols, codes and abbreviations - English and French terminology - verbal and written instructions	• Detail drawings in metric and imperial units of measurement • Symbols • Codes • Materials • Dimensioning

Specifications	Performance Criteria	Suggested Related Content
2. Develop the process sheet.	2.1 Determination of logical sequence of machining operations 2.2 Choice of boring mill in accordance with: - its capacity - the boring operations required 2.3 Choice of installation methods in accordance with: - the material to be machined - the boring operations required - the machining precision required 2.4 Proper identification of support and clamping points 2.5 Choice of cutting tools and mounting methods in accordance with: - their machining capacity - the material to be machined - the boring operations required - the capacity of the boring mill - the surface finishes - the optimization of the process 2.6 Proper choice of testing instruments and apparatus 2.7 Verification of availability of accessories, tools, measuring instruments and testing apparatus 2.8 Determination of: - machining parameters - travel coordinates 2.9 Careful sketch of workpiece in machining position	• Routines, subroutines and operations • Productivity and quality resulting from the sequence of operations • Components of the boring mill • Condition and capacity of the boring mill: length between centres, turning diameter, accessories, rpm, feed and increment • Isostasy • Characteristics of a proper installation • Safety rules applicable to installation • Cutting tools: material and grade, physical characteristics and heat effects of cut • Geometry of cutting tools and terminology: angles, radii, chip breaker, shapes and sizes • Calculation of cutting parameters: rpm, feed rate and depth of cut • Use of tables and nomographs • Travel coordinates: machining allowance and polar coordinates • Measuring instruments in metric and imperial units of measurement: rulers, vernier calliper, micrometer callipers, dial gauge, protractor, dividers, etc. • Testing apparatus: roughness tester, parallels, gauge blocks, V blocks, sine bar, etc. • Isostatic symbols (support, clamping, etc.), dimensioning and highlighting of surfaces to be machined

Specifications	Performance Criteria	Suggested Related Content
3. Mount the workpiece on the boring mill.	3.1 Visual and manual inspection of boring mill and mounting accessories 3.2 Appropriate corrections made 3.3 Installation of accessories in accordance with the mounting method: - three-jaw chucks - four-jaw chucks - flexible collets 3.4 Proper positioning and alignment of workpiece 3.5 Safe installation of workpiece on boring mill	• Characteristics of a proper installation • Handling of workpiece and mounting accessories • Condition and maintenance of accessories • Alignment of tailstock • Method of mounting accessories • Orientation of workpiece • Clamping technique and effect on workpiece
4. Prepare the boring mill and the work station.	4.1 Visual and manual inspection of cutting tools, measuring instruments and accessories 4.2 Appropriate corrections made 4.3 Proper positioning and mounting of cutting tools 4.4 Adjustments in conformity with process sheet: - feed rate - rpm - compound rest 4.5 Organized arrangement of instruments 4.6 Observance of health and safety rules	• Inspection of cut • Sharpening and replacement of tip • Adjustment of tool height • Orientation of tool • Proper mounting of tool • Verification of availability of testing, calibration and adjustment instruments

Specifications	Performance Criteria	Suggested Related Content
5. Perform boring operations, such as: - drilling - reaming - boring - chamfering - grooving	5.1 Conformity with process sheet 5.2 Observance of roughing and finishing techniques in accordance with the type of operation performed 5.3 Safe use of boring mill 5.4 Accurate identification of machining problems 5.5 Appropriate corrections made to: - the machining process - the process sheet 5.6 Confirmation of validity of corrections with the appropriate person at the appropriate time 5.7 Proper use of cutting fluids and coolants 5.8 Machining in conformity with drawings 5.9 Careful deburring and cleaning of part	• Kinematic chain of boring mill • Start-up • Movement of carriages • Increments • Effect of the cut on the workpiece: thermal expansion and deformation • Method of using cutting fluids and coolants • Techniques for performing different operations, including roughing and finishing • Inspection during the machining process: dimensional, form and positioning tolerances, and roughness index • Deburring techniques • Health and safety rules
6. Control the quality of the machined part.	6.1 Accurate identification of dimensions 6.2 Observance of dimensional, form and positioning tolerances 6.3 Proper control of surface finishes 6.4 Proper presentation of results in reports 6.5 Careful cleaning and storage of measuring devices and instruments	• Inspection of linear and angular dimensions, form and positioning tolerances, and surfaces • Direct and indirect measuring instruments • Other necessary inspection devices or instruments • Calibration and adjustment • Roughness tester • Concepts of self-inspection

Specifications	Performance Criteria	Suggested Related Content
7. Perform regular maintenance on the boring mill, accessories and cutting tools.	7.1 Proper cleaning and storage of the machine tool, tools and accessories, and proper cleaning of work area 7.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 7.3 Appropriate corrections made 7.4 Lubrication by hand at the appropriate points 7.5 Appropriate reporting of abnormalities 7.6 Observance of health and safety rules 7.7 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Lubrication methods • Types of lubricants: soluble oils, lubricating oils, hydraulic oils and greases • Lubrication points • Treatment or replacement of substandard soluble oils • Health risks associated with contaminated coolants • Disposal of used oil • Detection of abnormal vibrations and noises • Standards of cleanliness

MODULE 11: LONGITUDINAL AND TRANSVERSE MACHINING ON A MILLING MACHINE CODE: 872 118 120 HOURS

Harmonization:
The content of Modules 11, 13 and 17 of this program is equivalent to competency 012R of *Mechanical Engineering Technology* (DEC).
The content of Modules 9, 10, 11, 12, 13 and 17 of this program corresponds to competency 011S of *Aircraft Manufacturing Technology* (DEC).

Expected Behaviour	Conditions for Performance Evaluation	Suggested Approach
Perform longitudinal and transverse machining operations on a milling machine.	• Given: - drawings of simple parts to be machined in metric or imperial units of measurement - instructions - bar stock with a high machinability rating - conventional horizontal and vertical milling machines and their accessories - conventional and new types of rapid steel or carbide tools - testing instruments and apparatus - products - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues • Following health and safety rules	• Encourage the students to use new types of cutting tools. • At the beginning of the module, provide the students with process sheets and have them interpret them and then gradually design their own simple process sheets. • Provide the students with drawings without fit tolerances appropriate to their level of skill.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings and manuals, the information needed for the job.	1.1 Accurate identification of: - dimensions - dimensional, form and positioning tolerances - characteristics of surface finishes - type of materials 1.2 Accurate interpretation of manufacturing standards related to machine parts 1.3 Proper identification of information in the list of terms used, the title block and the annotations 1.4 Accurate identification of reference surfaces 1.5 Accurate interpretation of: - symbols, codes and abbreviations - English and French terminology - verbal and written instructions	• Detail drawings in metric and imperial units of measurement • Symbols • Codes • Materials • Dimensioning

Specifications	Performance Criteria	Suggested Related Content
2. Develop the process sheet.	2.1 Determination of logical sequence of machining operations 2.2 Choice of milling machine in accordance with: - its capacity - the milling operations required 2.3 Choice of mounting methods in accordance with: - the material to be machined - the longitudinal and transverse machining operations required - the machining precision required 2.4 Proper identification of support and clamping points 2.5 Choice of cutting tools and mounting methods in accordance with: - their machining capacity - the material to be machined - the milling operations required - the capacity of the milling machine - the surface finishes - the optimization of the process 2.6 Proper choice of testing instruments and apparatus 2.7 Verification of availability of accessories, tools, measuring instruments and testing apparatus 2.8 Determination of: - machining parameters - travel coordinates 2.8 Careful sketch of workpiece in machining position	• Routines, subroutines and operations • Productivity and quality resulting from the sequence of operations • Components of the milling machine • Condition and capacity of the milling machine: table dimensions, movement of the table along the x, y and z axes, accessories, rpm, feed and increment • Isostasy • Characteristics of a proper installation • Safety rules applicable to installation • Cutting tools: material and grade, physical characteristics and heat effects of cut • Geometry of cutting tools and terminology: angles, radii, chip breaker, shapes and sizes • Calculation of cutting parameters: rpm, feed rate and depth of cut • Use of tables and nomographs • Travel coordinates: machining allowance and polar coordinates • Measuring instruments in metric and imperial units of measurement: rulers, vernier calliper, micrometer callipers, dial gauge, protractor, dividers, etc. • Testing apparatus: roughness tester, parallels, gauge blocks, V blocks, sine bar, etc. • Isostatic symbols (support, clamping, etc.), dimensioning and highlighting of surfaces to be machined

Specifications	Performance Criteria	Suggested Related Content
3. Mount the workpiece on the milling machine.	3.1 Visual and manual inspection of milling machine and mounting accessories 3.2 Appropriate corrections made 3.3 Installation of accessories in accordance with the mounting method: - using a vice - directly on the table - using a V block 3.4 Proper positioning and alignment of workpiece 3.5 Safe installation of workpiece on milling machine	• Characteristics of a proper installation • Handling of workpiece and mounting accessories • Condition and maintenance of accessories • Alignment of table • Method of mounting accessories • Orientation of workpiece • Clamping technique and effect on workpiece
4. Prepare the milling machine and the work station.	4.1 Visual and manual inspection of cutting tools, measuring instruments and accessories 4.2 Appropriate corrections made 4.3 Proper positioning and mounting of cutting tools 4.4 Adjustments in conformity with process sheet: - feed rate - rpm - safety stops - incline of milling head 4.5 Organized arrangement of instruments 4.6 Observance of health and safety rules	• Inspection of cut • Replacement of tip • Adjustment of tool height • Alignment of milling head • Proper mounting of tool • Verification of availability of testing, calibration and adjustment instruments • Arrangement of instruments

Specifications	Performance Criteria	Suggested Related Content
5. Perform longitudinal and transverse machining operations, such as: - facing - straight grooving - peripheral milling - face milling - gang milling	5.1 Conformity with process sheet 5.2 Observance of roughing and finishing techniques in accordance with the type of operation performed 5.3 Safe use of milling machine 5.4 Accurate identification of machining problems 5.5 Appropriate corrections made to: - the machining process - the process sheet 5.6 Confirmation of validity of corrections with the appropriate person at the appropriate time 5.7 Proper use of cutting fluids and coolants 5.8 Machining in conformity with drawings 5.9 Careful deburring and cleaning of part	• Kinematic chain of milling machine • Start-up • Movements of tables and spindle • Increments • Effects of cut on workpiece: thermal expansion and deformation • Method of using cutting fluids and coolants • Techniques for performing the different operations, including roughing and finishing • Inspection during the machining process: dimensional, form and positioning tolerances, and roughing index • Deburring techniques • Health and safety rules
6. Control the quality of the machined part.	6.1 Accurate identification of dimensions 6.2 Observance of dimensional, form and positioning tolerances 6.3 Proper control of surface finishes 6.4 Proper presentation of results in reports 6.5 Careful cleaning and storage of measuring devices and instruments	• Inspection of linear and angular dimensions, form and positioning tolerances, and surfaces • Direct and indirect measuring instruments • Other necessary inspection devices or instruments • Calibration and adjustment • Roughness tester • Concepts of self-inspection

Specifications	Performance Criteria	Suggested Related Content
7. Perform regular maintenance on the milling machine, accessories and cutting tools.	7.1 Proper cleaning and storage of the machine tool, tools and accessories, and proper cleaning of work area 7.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 7.3 Appropriate corrections made 7.4 Lubrication by hand at the appropriate points 7.5 Appropriate reporting of abnormalities 7.6 Observance of health and safety rules 7.7 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Lubrication methods • Types of lubricants: soluble oils, lubricating oils, hydraulic oils and greases • Lubrication points • Treatment or replacement of substandard soluble oils • Health risks associated with contaminated coolants • Disposal of used oil • Detection of abnormal vibrations and noises

MODULE 12: THREAD CUTTING ON A LATHE **CODE: 872 125 75 HOURS**

Harmonization:
The content of Modules 9, 10 and 12 of this program is equivalent to competency 012Q of *Mechanical Engineering Technology* (DEC).
The content of Modules 9, 10, 11, 12, 13 and 17 of this program corresponds to competency 011S of *Aircraft Manufacturing Technology* (DEC).

Expected Behaviour	Conditions for Performance Evaluation	Suggested Approach
Cut threads on a lathe.	• Given: - drawings including threading operations in the metric and imperial systems of measurement - instructions - bar stock with a high machinability rating - conventional lathes and their accessories or threading attachments - conventional and new types of rapid steel or carbide tools - testing instruments and apparatus - products - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues • Following health and safety rules	• Encourage the students to use new types of cutting tools. • At the beginning of the module, provide the students with process sheets and have them interpret them and then gradually design their own simple process sheets. • Provide the students with drawings without fit tolerances appropriate to their level of skill.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings and manuals, the information needed for the job.	1.1 Accurate identification of: - dimensions - dimensional, form and positioning tolerances, and backlash - characteristics of surface finishes - type of materials 1.2 Accurate interpretation of manufacturing standards related to machine parts 1.3 Proper identification of information in the list of terms used, the title block and the annotations 1.4 Accurate identification of reference surfaces 1.5 Accurate interpretation of: - symbols, codes and abbreviations - English and French terminology - verbal and written instructions	• Detail drawings in metric and imperial units of measurement • Symbols • Codes • Materials • Dimensioning

Specifications	Performance Criteria	Suggested Related Content
2. Develop the process sheet.	2.1 Determination of logical sequence of machining operations 2.2 Choice of lathe in accordance with: - its capacity - the threading operations required 2.3 Choice of mounting methods in accordance with: - the material to be machined - the threading operations required - the machining precision required 2.4 Proper identification of support and clamping points 2.5 Choice of cutting tools or threading attachments and their installation in accordance with: - their machining capacity - the material to be machined - the threading operations required - the capacity of the lathe - the thread class - the surface finishes - the optimization of the process 2.6 Proper choice of testing instruments and apparatus 2.7 Verification of availability of accessories, tools, measuring instruments and testing apparatus 2.8 Determination of: - machining parameters - travel coordinates 2.9 Careful sketch of workpiece in machining position	• Routines, subroutines and operations • Productivity and quality resulting from the sequence of operations • Components of the lathe • Condition and capacity of the lathe: length between centres, turning diameter, accessories, rpm, unavailable threads and increment • Isostasy • Characteristics of a proper installation • Safety rules applicable to installation • Cutting tools: material and grade, physical characteristics and heat effects of cut • Threading attachments • Geometry of cutting tools and terminology: angles, radii, chip breaker, shapes and sizes • Calculation of cutting parameters: rpm, feed rate, depth of cut and offset dimensions • Use of tables and nomographs • Travel coordinates: machining allowance and polar coordinates • Measuring instruments in metric and imperial units of measurement: rulers, vernier calliper, micrometer callipers, dial gauge, protractor, dividers, etc. • Testing apparatus: roughness tester, parallels, gauge blocks, V blocks, sine bar, etc. • Isostatic symbols (support, clamping, etc.), dimensioning and highlighting of surfaces to be machined

Specifications	Performance Criteria	Suggested Related Content
3. Mount the workpiece on the lathe.	3.1 Visual and manual inspection of lathe and mounting accessories 3.2 Appropriate corrections made 3.3 Proper mounting of accessories on the lathe, according to the type of installation: - three-jaw chuck - four-jaw chuck - flexible collets 3.4 Proper positioning and alignment of workpiece 3.5 Safe installation of workpiece on lathe	• Characteristics of a proper installation • Handling of workpiece and mounting accessories • Condition and maintenance of accessories • Alignment of tailstock • Method of mounting accessories • Orientation of workpiece • Clamping technique and effect on workpiece
4. Prepare the lathe and the work station.	4.1 Visual and manual inspection of cutting tools, measuring instruments and accessories 4.2 Appropriate corrections made 4.3 Proper positioning and mounting of cutting tools 4.4 Adjustments in conformity with process sheet: - feed rate - rpm - compound rest, automatic threading die or threading head 4.5 Organized arrangement of instruments 4.6 Observance of health and safety rules	• Inspection of cut • Sharpening and replacement of tip • Adjustment of tool height • Orientation of tool • Proper mounting of tool • Verification of availability of testing, calibration and adjustment instruments • Arrangement of instruments

Specifications	Performance Criteria	Suggested Related Content
5. Perform internal and external threading operations, such as: - cutting unified threads - cutting acme threads - cutting ISO 60° threads - cutting trapezoidal threads	5.1 Conformity with process sheet 5.2 Observance of roughing and finishing techniques in accordance with the type of operation performed 5.3 Safe use of lathe and threading attachment 5.4 Accurate identification of machining problems 5.5 Appropriate corrections made to: - the machining process - the process sheet 5.6 Confirmation of validity of corrections with the appropriate person at the appropriate time 5.7 Proper use of cutting fluids and coolants 5.8 Machining in conformity with drawings 5.9 Careful deburring and cleaning of part	• Kinematic chain of lathe • Start-up • Movement of carriages • Increments • Effects of cut on workpiece: thermal expansion and deformation • Method of using cutting fluids and coolants • Method of using threading attachments • Techniques for performing the different operations, including roughing and finishing • Inspection during the machining process: dimensional, form and positioning tolerances, and roughness index • Deburring techniques • Health and safety rules
6. Control the quality of the threads.	6.1 Accurate identification of dimensions 6.2 Observance of dimensional, form and positioning tolerances 6.3 Proper control of surface finishes 6.4 Proper presentation of results in reports 6.5 Careful cleaning and storage of measuring devices and instruments	• Inspection of linear and angular dimensions, form and positioning tolerances, and surfaces • Direct and indirect measuring instruments • Other necessary inspection devices and instruments, such as a go, no-go gauge and three-wire method • Calibration and adjustment • Roughness tester • Concepts of self-inspection • Inspection sheets and reports

Specifications	Performance Criteria	Suggested Related Content
7. Perform regular maintenance on the lathe, accessories and cutting tools.	7.1 Proper cleaning and storage of the machine tool, tools and accessories, and proper cleaning of work area 7.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 7.3 Appropriate corrections made 7.4 Lubrication by hand at the appropriate points 7.5 Appropriate reporting of abnormalities 7.6 Observance of health and safety rules 7.7 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Storage methods • Lubrication methods • Types of lubricants: soluble oils, lubricating oils, hydraulic oils and greases • Lubrication points • Treatment or replacement of substandard soluble oils • Health risks associated with contaminated coolants • Disposal of used oil • Detection of abnormal vibrations and noises

MODULE 13: DRILLING AND REAMING USING A MILLING MACHINE — CODE: 872 133 — 45 HOURS

Harmonization:
The content of Modules 11, 13 and 17 of this program is equivalent to competency 012R of *Mechanical Engineering Technology* (DEC).
The content of Modules 9, 10, 11, 12, 13 and 17 of this program corresponds to competency 011S of *Aircraft Manufacturing Technology* (DEC).

Expected Behaviour	Conditions for Performance Evaluation	Suggested Approach
Perform drilling and reaming operations on a milling machine.	• Given: - drawings of simple parts to be machined in metric or imperial units of measurement - instructions - bar stock with a high machinability rating - conventional horizontal or vertical milling machines and their accessories - reaming attachments - conventional and new types of rapid steel or carbide tools - testing instruments and apparatus - products - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues • Following health and safety rules	• Encourage the students to use new types of cutting tools. • At the beginning of the module, provide the students with process sheets and have them interpret them and then gradually design their own simple process sheets. • Provide the students with drawings without fit tolerances appropriate to their level of skill.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings and manuals, the information needed for the job.	1.1 Accurate identification of: - dimensions - dimensional, form and positioning tolerances - characteristics of surface finishes - type of materials 1.2 Accurate interpretation of manufacturing standards related to machine parts 1.3 Proper identification of information in the list of terms used, the title block and the annotations 1.4 Accurate identification of reference surfaces 1.5 Accurate interpretation of: - symbols, codes and abbreviations - English and French terminology - verbal and written instructions	• Detail drawings in metric and imperial units of measurement • Symbols • Codes • Materials • Dimensioning

Specifications	Performance Criteria	Suggested Related Content
2. Develop the process sheet.	2.1 Determination of logical sequence of machining operations 2.2 Choice of milling machine in accordance with: - its capacity - the drilling and reaming operations required 2.3 Choice of mounting methods in accordance with: - the material to be machined - the drilling and reaming operations required - the machining precision required 2.4 Proper identification of support and clamping points 2.5 Choice of cutting tools and attachments and mounting methods in accordance with: - their machining capacity - the material to be machined - the drilling, reaming and tapping operations required - the capacity of the milling machine - the surface finishes - the optimization of the process 2.6 Proper choice of testing instruments and apparatus 2.7 Verification of availability of accessories, tools, measuring instruments and testing apparatus 2.8 Determination of: - machining parameters - travel coordinates 2.9 Careful sketch of workpiece in machining position	• Routines, subroutines and operations • Productivity and quality resulting from the sequence of operations • Components of the milling machine • Condition and capacity of the milling machine and attachments: table dimensions, movement of table and spindle, accessories, rpm, feed and increment • Isostasy • Characteristics of a proper installation • Safety rules applicable to installation • Cutting tools: material and grades, physical characteristics and thermal effects of the cut (reamer, microbore boring bar and reaming attachment) • Geometry of cutting tools and terminology: angles, radii, chip breaker, shapes and sizes • Calculation of cutting parameters: rpm, feed rate and depth of cut • Use of tables and nomographs • Travel coordinates: machining allowance and polar coordinates • Measuring instruments in metric and imperial units of measurement: rulers, vernier calliper, micrometer callipers, dial gauge, protractor, dividers, etc. • Testing apparatus: roughness tester, parallels, gauge blocks, V blocks, sine bar, etc. • Isostatic symbols (support, clamping, etc.), dimensioning and highlighting of surfaces to be machined

Specifications	Performance Criteria	Suggested Related Content
3. Mount the workpiece on the milling machine.	3.1 Visual and manual inspection of milling machine and mounting accessories 3.2 Appropriate corrections made 3.3 Proper mounting of accessories, in accordance with the type of installation: - using a vice - directly on the table - using V blocks 3.4 Proper positioning and alignment of workpiece 3.5 Safe installation of workpiece on milling machine	• Characteristics of a proper installation • Handling of workpiece and mounting accessories • Condition and maintenance of accessories • Alignment of table • Method of mounting accessories • Orientation of workpiece • Clamping technique and effect on workpiece
4. Prepare the milling machine and the work station.	4.1 Visual and manual inspection of cutting tools, measuring instruments and accessories 4.2 Appropriate corrections made 4.3 Proper positioning and mounting of cutting tools and attachments, as applicable 4.4 Adjustments in conformity with process sheet: - feed rate - rpm - incline of table - reaming and tapping adjustments, microbore boring bar or adjustable reamer, as needed 4.5 Organized arrangement of instruments 4.6 Observance of health and safety rules	• Inspection of cut • Sharpening and replacement of tip • Adjustment of tool height • Orientation of tool • Proper mounting of tool • Verification of availability of testing, calibration and adjustment instruments

Specifications	Performance Criteria	Suggested Related Content
5. Perform horizontal and vertical drilling and reaming operations, such as: - reaming - boring with a microbore boring bar - reaming with a reaming attachment - facing - counterboring - milling - tapping	5.1 Conformity with process sheet 5.2 Observance of roughing and finishing techniques in accordance with the type of operation performed 5.3 Safe use of milling machine and reaming and tapping attachments 5.4 Accurate identification of machining problems 5.5 Appropriate corrections made to: - the machining process - the process sheet 5.6 Confirmation of validity of corrections with the appropriate person at the appropriate time 5.7 Proper use of cutting fluids and coolants 5.8 Machining in conformity with drawings 5.9 Careful deburring and cleaning of part	• Kinematic chain of reaming and tapping attachments • Start-up • Movement of tables and reaming and tapping attachments • Increments • Effects of cut on workpiece: thermal expansion and deformation • Method of using cutting fluids and coolants • Techniques for performing the different operations, including roughing and finishing • Methods of positioning the milling head and table • Inspection during the machining process: dimensional, form and positioning tolerances, and roughness index • Deburring techniques • Health and safety rules
6. Control the quality of the machined part.	6.1 Accurate identification of dimensions 6.2 Observance of dimensional, form and positioning tolerances 6.3 Proper control of surface finishes 6.4 Proper presentation of results in reports 6.5 Careful cleaning and storage of measuring devices and instruments	• Inspection of linear and angular dimensions, form and positioning tolerances, and surfaces • Direct and indirect measuring instruments • Other necessary inspection devices or instruments • Calibration and adjustment • Roughness tester • Concepts of self-inspection

Specifications	Performance Criteria	Suggested Related Content
7. Perform regular maintenance on the milling machine, accessories and cutting tools.	7.1 Proper cleaning and storage of the machine tool, tools and accessories, and proper cleaning of work area 7.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 7.3 Appropriate corrections made 7.4 Lubrication by hand at the appropriate points 7.5 Appropriate reporting of abnormalities 7.6 Observance of health and safety rules 7.7 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Lubrication methods • Types of lubricants: soluble oils, lubricating oils, hydraulic oils and greases • Lubrication points • Treatment or replacement of substandard soluble oils • Health risks associated with contaminated coolants • Disposal of used oil • Detection of abnormal vibrations and noises • Criteria related to cleanliness

MODULE 14: SURFACE GRINDING		CODE: 872 144 60 HOURS
Expected Behaviour	**Conditions for Performance Evaluation**	**Suggested Approach**
Grind flat surfaces.	• Given: - drawings including simple grinding operations in metric or imperial units of measurement - instructions - heat-treated workpieces - surface grinders and their accessories - grinding wheels - testing instruments and apparatus - products - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues • Following health and safety rules	• Encourage the students to use new types of grinding wheels. • At the beginning of the module, provide the students with process sheets and have them interpret them and then gradually design their own simple process sheets. • Provide the students with drawings without fit tolerances appropriate to their level of skill.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings and manuals, the information needed for the job.	1.1 Accurate identification of: - dimensions - dimensional, form and positioning tolerances - characteristics of surface finishes - type of materials 1.2 Accurate interpretation of manufacturing standards related to machine parts 1.3 Proper identification of information in the list of terms used, the title block and the annotations 1.4 Accurate identification of reference surfaces 1.5 Accurate interpretation of: - symbols, codes and abbreviations - English and French terminology - verbal and written instructions	• Detail drawings in metric and imperial units of measurement • Symbols • Codes • Materials • Dimensioning

Specifications	Performance Criteria	Suggested Related Content
2. Develop the process sheet.	2.1 Determination of logical sequence of machining operations 2.2 Choice of grinder in accordance with: - its capacity - the grinding operations required 2.3 Choice of mounting methods in accordance with: - the material to be machined - the grinding operations required - the machining precision required 2.4 Proper identification of support and clamping points 2.5 Choice of grinding wheels and mounting methods in accordance with: - their capacity for removing material - the material to be machined - the grinding operations required - the capacity of the grinder - the surface finishes - the optimization of the process 2.6 Proper choice of testing instruments and apparatus 2.7 Verification of availability of accessories, grinding wheels, instruments and testing apparatus 2.8 Determination of: - machining parameters - travel coordinates 2.9 Careful sketch of workpiece in machining position	• Routines, subroutines and operations • Productivity and quality resulting from the sequence of operations • Components of the grinder • Condition and capacity of the grinder: movement of the table and grinding wheel, size of the table, rpm, feed and increment • Isostasy • Characteristics of a proper installation • Safety rules related to the mounting of grinding wheels and workpieces • Grinding wheels: abrasives, size of grain, grade, structure and binder • Shapes of grinding wheels and terminology: angles, radii, shapes and sizes • Calculation of cutting parameters: rpm, feed rate and depth of cut • Use of tables and nomographs • Travel coordinates: machining allowance and polar coordinates • Measuring instruments in metric and imperial units of measurement: rulers, vernier calliper, micrometer callipers, dial gauge, protractor, dividers, etc. • Testing apparatus: roughness tester, parallels, gauge blocks, V blocks, sine bar, etc. • Isostatic symbols (support, clamping, etc.), dimensioning and highlighting of surfaces to be machined

Specifications	Performance Criteria	Suggested Related Content
3. Mount the workpiece on the grinder.	3.1 Visual and manual inspection of grinder and mounting accessories 3.2 Appropriate corrections made 3.3 Mounting of accessories on grinder in accordance with the type of installation: - magnetic table - magnetic V block - magnetic sine plate - angle plate 3.4 Proper positioning and alignment of workpiece 3.5 Safe installation of workpiece on grinder	• Characteristics of a proper installation • Handling of workpiece and mounting accessories • Condition and maintenance of accessories • Alignment of table or tailstock • Method of mounting accessories • Orientation of workpiece • Clamping technique and effect on workpiece • Adjustment of sine plate
4. Prepare the grinder and the work station.	4.1 Visual and manual inspection of grinding wheels, instruments and accessories 4.2 Appropriate corrections made 4.3 Proper positioning and mounting of grinding wheels 4.4 Adjustments in conformity with process sheet: - feed rate - rpm 4.5 Organized arrangement of instruments 4.6 Observance of health and safety rules	• Inspection of grinding wheel • Truing of grinding wheel • Shaping of grinding wheel • Safe mounting of grinding wheel • Verification of availability of testing, calibration and adjustment instruments • Organized arrangement of instruments

Specifications	Performance Criteria	Suggested Related Content
5. Perform surface grinding operations, such as: - straight grinding - transverse grinding - angle grinding	5.1 Conformity with process sheet 5.2 Observance of roughing and finishing techniques in accordance with the type of operation performed 5.3 Safe use of grinder 5.4 Accurate identification of grinding problems 5.5 Appropriate corrections made to: - the machining process - the process sheet 5.6 Confirmation of validity of corrections with the appropriate person at the appropriate time 5.7 Proper use of cutting fluids and coolants 5.8 Machining in conformity with drawings 5.9 Careful deburring and cleaning of part	• Kinematic chain of grinder • Start-up • Movement of table and grinding wheel • Increments • Effects of cut on workpiece: thermal expansion, deformation and burns • Method of using cutting fluids and coolants • Techniques for performing the different operations, including roughing and finishing • Inspection during the machining process: dimensional, form and positioning tolerances, and roughness index • Deburring techniques • Health and safety rules
6. Control the quality of the workpiece.	6.1 Accurate identification of dimensions 6.2 Observance of dimensional, form and positioning tolerances 6.3 Proper control of surface finishes 6.4 Proper presentation of results in reports 6.5 Careful cleaning and storage of measuring devices and instruments	• Inspection of linear and angular dimensions, form and positioning tolerances, and surfaces • Direct and indirect measuring instruments • Other necessary inspection devices or instruments • Calibration and adjustment • Roughness tester • Concepts of self-inspection • Inspection sheets and reports

Specifications	Performance Criteria	Suggested Related Content
7. Perform regular maintenance on the grinder, accessories and grinding wheels.	7.1 Proper cleaning and storage of the machine tool, grinding wheels and accessories and proper cleaning of work area 7.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 7.3 Appropriate corrections made 7.4 Lubrication by hand at the appropriate points 7.5 Appropriate reporting of abnormalities 7.6 Observance of health and safety rules 7.7 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Storage methods • Lubrication methods • Types of lubricants: soluble oils, lubricating oils, hydraulic oils and greases • Lubrication points • Treatment or replacement of substandard soluble oils • Health risks associated with contaminated coolants • Disposal of used oil • Detection of abnormal vibrations and noises

MODULE 15: NEW TYPES OF WORK ORGANIZATION — CODE: 872 153 — 45 HOURS

HARMONIZATION:
This module is equivalent to Module 11 of *Numerical Control Machine Tool Operation* (AVS), Module 23 of *Industrial Drafting* (DVS), competency 012X of *Mechanical Engineering Technology* (DEC) and competency 0127 of *Aircraft Manufacturing Technology* (DEC).

Expected Behaviour	Conditions for Performance Evaluation	Suggested Approach
Adapt to new types of work organization.	• Working in a team • Given complete information on the operation of a manufacturing company • Using relevant documentation • In an atmosphere of respect and openness	

Specifications	Performance Criteria	Suggested Related Content
1. Recognize the production management approaches of the company and their effects on the type of work organization.	1.1 Recognition of the company's management philosophy, particularly Taylorism and added value 1.2 Proper description of preferred type of structural organization: - hierarchical organization - semi-autonomous teams - autonomous teams 1.3 Recognition of the company's production process 1.4 Appreciation of the effects of management approaches on production and on the evolution of tasks in the company	
2. Recognize the means used to promote the continual improvement of productivity.	2.1 Accurate differentiation among the instruments or techniques used in the company 2.2 Relevant associations between the means used and the company's ability to meet the requirements of the new economy, such as: - improvement of the time required to respond to market needs - economies of scale - elimination of waste 2.3 Recognition of the contribution of personnel to the improvement of productivity	

Specifications	Performance Criteria	Suggested Related Content
3. Communicate verbally with colleagues.	3.1 Choice of types of questions required to obtain relevant information 3.2 Proper reformulation of areas of agreement and disagreement in a discussion 3.3 Proper reformulation and reflection of message 3.4 Constructive and accurate feedback to: - encourage improvement in behaviour - recognize and encourage the contribution of colleagues 3.5 Relevant and persuasive expression of their point of view 3.6 Understanding of controversial comments 3.7 Use of an effective approach to deal with emotional behaviour	• Communication process • Obstacles to communication • Role of perception and defence mechanisms • Facilitating attitudes • Types of questions • Reformulation • Reflection • Summary of discussions • Personal feedback based on experience • Acceptance of emotional behaviour • Arguments supporting an opinion
4. Solve problems related to work organization.	4.1 Choice of tools and techniques in accordance with the complexity of the problem to be solved 4.2 Clear description of the problem 4.3 Determination of the causes and consequences of the problem 4.4 Choice of best solution in accordance with established criteria 4.5 Realistic plan of action 4.6 Follow-up mechanisms clearly defined and scheduled	• Advantages of using a problem-solving process • Simple process • Modern tools and techniques

Specifications	Performance Criteria	Suggested Related Content
5. Work in a multidisciplinary team.	5.1 Determination of the goals of the team and the results to be attained in accordance with the company's mission and values 5.2 Consensus on team rules 5.3 Determination of the responsibilities of each team member 5.4 Proper planning of work 5.5 Consensus decision making 5.6 Recognition of style of participation of team members 5.7 Description of favourable and unfavourable factors for each stage of the work	• Bases of an effective work team • Cooperation as opposed to competition • Roles within the team • Team rules • Styles of participation • Planning stages • Consensus decision-making process • Stages in the growth of a work team

MODULE 16: INTRODUCTION TO THE WORKPLACE		CODE: 872 162 30 HOURS
Expected Outcome	**Instructional Guidelines**	**Suggested Approach**
Become familiar with the workplace. *Specifications:* Prepare a search for a practicum position. Examine the machining processes used in industry and the related conventional or new types of equipment. Observe work techniques at different work stations. Compare their learning achievements with the requirements of the trade and the situation observed.	• Make available to the students a variety of resource materials (reference manuals, brochures, pamphlets, telephone books, videotapes, etc.). • Provide the students with a sample résumé and letter of introduction. • Maintain close ties between the school and the company. • Make sure that the trainees receive the support and supervision of a responsible person in the company. • Make sure that the company respects the conditions required for the students to attain the objectives of the practicum. • Encourage the students to engage in discussions and express themselves. • Provide the students with a sample log.	• Approximately six hours should be devoted to Phase 1, Preparing a Practicum Search.

Learning Context	Participation Criteria	Suggested Related Content
PHASE 1: **Preparing a Practicum Search**	- Gather the information necessary for the practicum search. - Produce the required documents.	

• Learning about the objectives of the practicum and the related procedures.		• Each student's definition of his or her objectives for the practicum:
		  - information about the practicum
		  - instructional guidelines
		• Company rules

• Becoming familiar with sources of information about companies likely to hire trainees.		• Employment centres • Newspapers • Professional corporations • Businesses • Acquaintances in the job market • Personal contacts • Placement and recruitment agencies • List of companies in the region • Internet • Other
• Determining the steps involved in finding a practicum position or a job.		• Steps involved • Definition of each student's expectations and needs • Search for potential employers • Production and dispatch of a résumé and letter of introduction • Interviews • Follow-up with employers • Other

Learning Context	Participation Criteria	Suggested Related Content
• Writing a résumé and a letter of introduction.		• Résumé: - definition and purpose - qualities (organized presentation, clarity, neatness, etc.) - parts (identification, education and work experience, personality traits, personal experience, activities, references, etc.) • Letter of introduction: - definition and purpose - qualities (clarity, neatness, concision, etc.) - parts (date, name and title of addressee, name of company, type of job applied for, justification, request for an interview, address and telephone number, complimentary closing, signature)
• Determining the attitudes and behaviours to adopt or avoid in a selection interview.		• Attitudes and behaviours demonstrating competency and main assets • Neat appearance • Appropriate language • Appropriate, coherent remarks • Interest and dynamic attitude • Attitudes and behaviours to avoid
PHASE 2: **Participation in the Practicum**	- Follow company rules. - Note information on the situation observed.	
• Observing machinists as they perform various tasks.		• Working conditions • Structure of the company • Rules in force, especially with respect to health and safety • Machinists' tasks • Machining processes and related equipment • Other

Learning Context	Participation Criteria	Suggested Related Content
• Discussing the different aspects of the trade with experienced machinists.		• Search for explanations or details related to the above-mentioned subjects • Job prospects • Curiosity and interest in the trade • Positive, open attitude • Clear, precise communication
• Noting their observations in a log.		• Presentation of a sample log • Note-taking method • Concision, neatness and clarity
PHASE 3: **Evaluation of the Practicum**	- List their observations on the trade - Express their perception of the trade and the differences noted relative to the training, during a group discussion.	
• Listing their observations about: - the requirements of the trade - learning achievements and permanent learning - relevance of the training received with respect to the situation observed - their personal objectives		• List made according to the sample provided • Sharing of perceptions and opinions during a group discussion • List of their expectations and degree of satisfaction with the training received • Future training needs

MODULE 17: ANGULAR AND CIRCULAR MILLING ON A MILLING MACHINE CODE: 872 178 120 HOURS

HARMONIZATION:
The content of Modules 11, 13 and 17 of this program is equivalent to competency 012R of *Mechanical Engineering Technology* (DEC).
The content of Modules 9, 10, 11, 12, 13 and 17 of this program corresponds to competency 011S of *Aircraft Manufacturing Technology* (DEC).

Expected Behaviour	Conditions for Performance Evaluation	Suggested Approach
Perform angular and circular milling operations on a milling machine.	• Given: - drawings of workpieces in metric or imperial units of measurement - instructions - bar stock with a high machinability rating - conventional horizontal and vertical milling machines and their accessories - conventional and new types of rapid steel or carbide tools - testing instruments and apparatus - products - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues • Following health and safety rules	• Encourage the students to use new types of cutting tools. • At the beginning of the module, provide the students with process sheets and have them interpret them and then gradually design their own simple process sheets. • Provide the students with drawings without fit tolerances appropriate to their level of skill.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings and manuals, the information needed for the job.	1.1 Thorough identification of information needed for the job 1.2 Accurate interpretation of information 1.3 Accurate identification of reference surfaces 1.4 Accurate English and French terminology	• Detail drawings in metric and imperial units of measurement • Symbols • Codes • Materials • Dimensioning

Specifications	Performance Criteria	Suggested Related Content
2. Develop the process sheet.	2.1 Determination of logical sequence of machining operations 2.2 Choice of milling machine in accordance with: - its capacity - the angular and circular milling operations required 2.3 Choice of mounting methods in accordance with: - the material to be machined - the angular and circular milling operations required - the machining precision required 2.4 Proper identification of support and clamping points 2.5 Choice of cutting tools and mounting methods in accordance with: - their machining capacity - the material to be machined - the angular and circular milling operations required - the capacity of the milling machine - the surface finishes - the optimization of the process 2.6 Proper choice of testing instruments and apparatus 2.7 Verification of availability of accessories, tools, measuring instruments and testing apparatus 2.8 Determination of: - machining parameters - travel coordinates 2.9 Careful sketch of workpiece in machining position	• Routines, subroutines and operations • Productivity and quality resulting from the sequence of operations • Components of the milling machine • Condition and capacity of the milling machine and its accessories: clamping area, movement of the table along the x, y and z axes, rpm, feed and taper number of spindle • Isostasy • Characteristics of a proper installation • Safety rules applicable to installation • Cutting tools: material and grade, physical characteristics and heat effects of cut • Geometry of tools and terminology: angles, radii, shapes and sizes • Calculation of cutting parameters: rpm, feed rate and depth of cut • Calculation of control dimension using three-wire method • Use of tables and nomographs • Travel coordinates: machining allowance and polar coordinates • Measuring instruments in metric and imperial units of measurement: rulers, vernier calliper, micrometer callipers, dial gauge, protractor, dividers, etc. • Testing apparatus: roughness tester, parallels, gauge blocks, V blocks, sine bar, etc. • Isostatic symbols (support, clamping, etc.), dimensioning and highlighting of surfaces to be machined

Specifications	Performance Criteria	Suggested Related Content
3. Mount the workpiece on the milling machine.	3.1 Visual and manual inspection of milling machine and mounting accessories 3.2 Appropriate corrections made 3.3 Mounting of accessories on milling machine in accordance with the type of installation: - indexing attachment - rotary table - angle plate - V block - vice 3.4 Proper positioning and alignment of workpiece 3.5 Safe installation of workpiece on milling machine	• Characteristics of a proper installation • Handling of workpiece and mounting accessories • Condition and maintenance of accessories • Alignment of workpiece and mounting accessories • Method of mounting accessories • Orientation of workpiece • Clamping technique and effect on workpiece
4. Prepare the milling machine and the work station.	4.1 Visual and manual inspection of cutting tools, measuring instruments and accessories 4.2 Appropriate corrections made 4.3 Proper positioning and mounting of cutting tools 4.4 Adjustments in conformity with process sheet: - incline of milling head - feed rate - rpm - safety stops 4.5 Organized arrangement of instruments 4.6 Observance of health and safety rules	• Inspection of cut • Replacement of tip • Adjustment of cutting tool height • Orientation of tool • Proper mounting of tool • Verification of availability of testing, calibration and adjustment instruments • Arrangement of instruments

Specifications	Performance Criteria	Suggested Related Content
5. Perform angular and circular milling operations, such as: - facing - contouring - straight and angular grooving - drilling - reaming - dovetail cutting - V grooving	5.1 Conformity with process sheet 5.2 Observance of roughing and finishing techniques in accordance with the type of operation performed 5.3 Safe use of milling machine 5.4 Accurate identification of machining problems 5.5 Appropriate corrections made to: - the machining process - the process sheet 5.6 Confirmation of validity of corrections with the appropriate person at the appropriate time 5.7 Proper use of cutting fluids and coolants 5.8 Machining in conformity with drawings 5.9 Careful deburring and cleaning of part	• Kinematic chain of milling machine • Start-up • Linear, angular and circular movement of tables and mounting accessories • Increments • Effects of cut on workpiece: thermal expansion, deformation and burns • Methods of using cutting fluids and coolants • Techniques for performing the different operations, including roughing and finishing • Inspection during the machining process: dimensional, form and positioning tolerances, and roughness index • Deburring techniques • Health and safety rules
6. Control the quality of the machined part.	6.1 Conformity of part with requirements 6.2 Proper use of: - measuring instruments and devices - three-dimensional measuring machine 6.3 Proper presentation of results in reports 6.4 Careful cleaning and storage of measuring devices and instruments	• Inspection of linear and angular dimensions, form and positioning tolerances, and surfaces • Direct and indirect measuring instruments • Other necessary inspection devices or instruments • Calibration and adjustment • Roughness tester • Testing techniques using three-wire method • Concepts of self-inspection • Inspection sheets and reports

Specifications	Performance Criteria	Suggested Related Content
7. Perform regular maintenance on the milling machine, accessories and cutting tools.	7.1 Proper cleaning and storage of the machine tool, tools and accessories, and proper cleaning of work area 7.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 7.3 Appropriate corrections made 7.4 Lubrication by hand at the appropriate points 7.5 Appropriate reporting of abnormalities 7.6 Observance of health and safety rules 7.7 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Storage methods • Lubrication methods • Types of lubricants: soluble oils, lubricating oils, hydraulic oils and greases • Lubrication points • Treatment or replacement of substandard soluble oils • Health risks associated with contaminated coolants • Disposal of used oil • Detection of abnormal vibrations and noises

MODULE 18: MATHEMATICS RELATED TO MUMERICAL CONTROL MACHINING **CODE: 872 182 30 HOURS**

HARMONIZATION:
This module is equivalent to Module 3 of *Numerical Control Machine Tool Operation* (AVS).

Expected Behaviour	Conditions for Performance Evaluation	Suggested Approach
Solve mathematical problems related to numerical control machining.	• Given: - drawings of workpieces to be machined on numerical control machine tools in metric and imperial units of measurement - written instructions - the necessary technical documentation, course notes and mathematical formulae - a scientific calculator	• Have the students solve problems in both the metric and imperial systems of measurement. • Demand serious, careful work. • Provide students with individualized support. • Review the methods of solving right-angle and other types of triangles. • Help the students develop competencies in trigonometry, analytic geometry and problem solving. • Integrate the learning in this module into the manual programming of machining projects.

Specifications	Performance Criteria	Suggested Related Content
1. Do calculations related to dimensions.	1.1 Thorough identification of tolerance limits in tables 1.2 Proper choice of formulae 1.3 Accurate calculation of missing and average dimensions: - lengths - diameters - radii - angles 1.4 Accurate conversions between the metric and imperial systems of measurement	• Method of consulting tables and nomographs • Items to be found in reference tables and technical manuals: values related to programming and quality control • Dimensional tolerances in accordance with international and American standards • Method of calculating missing and average dimensions • Metric and imperial systems of measurement • Use of a scientific calculator
2. Analyze the geometrical configuration of workpieces to be machined on numerical control machine tools.	2.1 Thorough identification of geometric shapes 2.2 Accurate breakdown of shape of workpiece into geometric elements 2.3 Relevance of geometric elements to the calculation of coordinates 2.4 Neatness and clarity of elements represented	• Method of constructing geometric figures: parallel lines, perpendicular lines, tangents, secants, medians, bisectors, height, rectangles, squares, parallelograms, trapezoids, rhomboids, regular and irregular polygons, circles and arcs • Method of breaking down geometric figures • Advanced concepts of analytic geometry

Specifications	Performance Criteria	Suggested Related Content
3. Calculate the rectangular and polar coordinates needed to program numerical control machine tools.	3.1 Proper choice of elements to be calculated 3.2 Accurate identification, in the drawings and manuals, of the information needed for the calculations 3.3 Proper application of: - formula - Pythagorean theorem - trigonometric functions - law of sines and cosines 3.4 Accurate transformation of formula 3.5 Accurate calculation of points of intersection, connection and tangency for: - absolute programming - incremental programming - composite programming 3.6 Accurate calculation of the centres of arcs 3.7 Use of signs in accordance with the different quadrants 3.8 Accurate conversions of: - rectangular and polar coordinates - the metric and imperial systems of measurement 3.9 Observance of problem-solving process	• Items to be located in the drawings: - dimensions - tolerance limits, including fit tolerances - annotations - title block - symbols • Decimals and fractions • System of axes for the different numerical control machine tools: lathes, horizontal and vertical milling machines • Terminology related to the Cartesian coordinate system: axes, origin, abscissa, ordinate, sign, rectangular and polar coordinates, etc. • Degree of precision in accordance with the capacity of the controllers for different numerical control machine tools • Solution of right-angle triangles: Pythagorean theorem and trigonometric functions • Solution of other types of triangles: law of sines and cosines • Technique of solving a triangle by breaking it down into right-angle triangles • Application and transformation of formulae • Summary table of solution of right-angle and other types of triangles • Solution of problems requiring analysis and reasoning • Analytic geometry formulae: line, diameter, radius, tangent, circumference, arc, arrow and secant • Method of calculating points of intersection, connection and tangency of different geometric shapes: line segments and arcs • Method of calculating radius compensation • Method of calculating the centre of radii of arcs constituting the shape to be created • Metric and imperial systems of measurement • Use of a scientific calculator

MODULE 19: MANUAL PROGRAMMING OF A NUMERICAL CONTROL LATHE — CODE: 872 194 60 HOURS

HARMONIZATION:
This module is equivalent to Module 4 of *Numerical Control Machine Tool Operation* (AVS) and competency 0133 of *Mechanical Engineering Technology* (DEC).

Expected Behaviour	Conditions for Performance Evaluation	Suggested Approach
Program a numerical control lathe manually.	• Given: - drawings of simple parts to be machined in metric or imperial units of measurement - process sheets - instructions - industrial numerical control lathes or a microcomputer with a text editor and communication software - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues - programming manuals • Following occupational health and safety rules	• Have the students write programs in both the metric and imperial systems of measurement. • Demand serious, careful work. • Provide students with individualized support. • Mounting techniques and cutting technology will be dealt with in subsequent modules. • In order to better integrate the learning in manual programming, this competency should be taught concurrently with the competency *Machine simple parts on a numerical control lathe*.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings, process sheet and manuals, the information needed for the job.	1.1 Thorough identification of information needed for the job 1.2 Accurate interpretation of information 1.3 Accurate identification of reference surfaces 1.4 Accurate English and French terminology	• Dimensions (length, diameter, radius, angle, etc.) • Tolerance limits: - international standards - American standards • Dimensional, form and positioning tolerances • Surface finishes • Basic symbols and symbols specific to numerical control • Reference surfaces and surfaces to be machined • Conventional and absolute dimensioning • Characteristics of lathe (e.g. capacity) • Productivity and quality resulting from the sequence of operations • Cutting tools and tool holders specific to numerical control lathes
2. Write the program.	2.1 Proper choice of zero position of workpiece 2.2 Accurate calculation of rectangular and polar coordinates, as needed 2.3 Determination of position of beginning and end of toolpath 2.4 Structured development of program 2.5 Accurate insertion of machining parameters specific to turning: - cutting speed in units per minute - feed rate in units per revolution 2.6 Conformity with process sheet 2.7 Observance of programming syntax	• Systems of axes specific to numerical control lathes • Incremental and absolute methods • Methods of calculating average dimensions • Programming design: - position of tool at each point of intersection - zero position - toolpath • Metric and imperial systems of measurement • Preparatory, miscellaneous and information functions • Canned and fixed cycles • Cutter compensation • Translation of toolpaths into machine language • Other

Specifications	Performance Criteria	Suggested Related Content
3. Edit the program using: - a microcomputer - the machine tool controller	3.1 Observance of procedure, in accordance with the material used: - data entry - data archiving - data transmission 3.2 Inclusion of all program data 3.3 Accurate data entered	• Editing method using a microcomputer with a text editor • Editing method using the machine tool controller • Methods of archiving data: - hard disk - diskette - cassette - tape - other • Method of transmitting data using different media
4. Validate the program.	4.1 Conformity of program with drawing and instructions 4.2 Detailed simulation of toolpaths: - graphic simulation - no-load test 4.3 Detection of programming errors 4.4 Appropriate corrections made 4.5 Observance of archiving method 4.6 Observance of time limits	• Method of graphic simulation • Method of no-load test of program on machine tool controller without graphic simulator • Problem-solving methods • Frequent errors

MODULE 20: BASIC MACHINING ON A NUMERICAL CONTROL LATHE **CODE: 872 206** **90 HOURS**

HARMONIZATION:
This module is equivalent to Module 5 of *Numerical Control Machine Tool Operation* (AVS). The content of Modules 20 and 22 of this program is equivalent to competency 012V of *Mechanical Engineering Technology* (DEC).

Expected Behaviour	Conditions for Performance Evaluation	Suggested Approach
Machine simple parts on a numerical control lathe.	• Given: - drawings of parts requiring external turning only in metric or imperial units of measurement - instructions - materials with a high machinability rating - industrial numerical control lathes (programming could also be done using a microcomputer with a text editor and communication software) - conventional carbide and new types of high performance cutting tools - testing instruments and apparatus (including a three-dimensional measuring machine) - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues - programming manuals • Following occupational health and safety rules	• Have the students write programs in both the metric and imperial systems of measurement. • Demand serious, careful work. • Provide students with individualized support. • Devote 10 percent of teaching time to mounting methods and cutting tools used on numerical control lathes. • Perform manual operations on the numerical control lathe at the very beginning of the module. • Machine the first part using a program written by the instructor. • Set up the process sheet, installations and programming for mass production. • At this stage of the program, use drawings with a minimum of geometric tolerances. • The projects to be done should gradually increase in complexity. • To favour the integration of this competency, teach it concurrently with the competency *Program a numerical control lathe manually*. • Use both incremental and absolute programming methods. • Apply concepts of self-inspection to numerical control.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings and manuals, the information needed for the job.	1.1 Thorough identification of information needed for the job 1.2 Accurate interpretation of information 1.3 Accurate identification of reference surfaces 1.4 Accurate English and French terminology	• Characteristics of numerical control lathes • Productivity and quality resulting from the sequence of operations • Types of installation in accordance with the machining operation and the shape of the workpiece • Characteristics of a proper installation • Safety rules related to installation • Cutting tools and tool holders specific to numerical control lathes • Machining conditions: - a minimum of chips - wear and useful life of tools - required power - other • Applications of cutting fluids • Awareness of the physical phenomena that occur during machining: - bending - vibration (resonance) • Calculation of machining parameters in accordance with information in tool manufacturers' catalogues • Use of tables and nomographs • Direct and indirect measuring instruments • Testing apparatus • Mounting accessories specific to numerical control lathes • Quality of surface finish in accordance with feed and type of tool

Specifications	Performance Criteria	Suggested Related Content
2. Develop the process sheet.	2.1 Determination of a logical sequence of turning operations 2.2 Choice of lathe in accordance with: - its capacity - the turning operations required 2.3 Choice of installation methods in accordance with: - the material to be machined - the turning operations required - the machining precision required 2.4 Proper identification of support and clamping points 2.5 Choice of cutting tools and mounting methods in accordance with: - their machining capacity - the material to be machined - the turning operations required - the capacity of the lathe - the surface finishes - the optimization of the process 2.6 Proper choice of testing instruments and apparatus 2.7 Verification of availability of lathe, accessories, cutting tools, measuring instruments and testing apparatus 2.8 Determination of machining parameters 2.9 Careful sketch of workpiece in machining position	• Systems of axes specific to numerical control lathes: - system of machine axes - system of axes of the workpiece • Incremental and absolute methods • Programming design: - position of tool at each point of intersection - zero position of workpiece - toolpaths • Metric and imperial systems of measurement • Use of a scientific calculator • Preparatory, miscellaneous and information functions • Canned and fixed cycles • Cutter compensation • Editing using a microcomputer with a text editor or the machine tool controller • Method of archiving data • Transmission of data using different media

Specifications	Performance Criteria	Suggested Related Content
3. Program the numerical control lathe.	3.1 Accurate calculation of rectangular and polar coordinates 3.2 Proper choice of zero position of workpiece 3.3 Determination of toolpaths 3.4 Proper translation of toolpaths into machine language 3.5 Conformity with process sheet 3.6 Proper editing of program: - using a computer - using the machine tool controller 3.7 Thorough verification of inclusion and accuracy of program data	
4. Mount the workpiece on the numerical control lathe.	4.1 Visual and manual inspection of machine tool and mounting accessories 4.2 Appropriate corrections made 4.3 Proper installation of mounting accessories on machine tool 4.4 Proper positioning and alignment of workpiece 4.5 Safe installation of workpiece on numerical control lathe	• Characteristics of a proper installation • Handling of workpiece and mounting accessories • Condition and maintenance of accessories • Alignment of: – tailstock – lathe spindle – turret • Method of mounting accessories • Position and orientation of workpiece • Clamping technique and effect on workpiece • Hydraulic pressure of chuck, tailstock and tailstock spindle in accordance with the dimensions and rpm of the workpiece • Soft-jaw and hard-jaw chucks • Machining of soft jaws • Other

Specifications	Performance Criteria	Suggested Related Content
5. Prepare the numerical control lathe.	5.1 Visual and manual inspection of accessories and cutting tools 5.2 Appropriate corrections made 5.3 Proper installation of cutting tools 5.4 Proper adjustment of tool offset, feed, cutting speed and spray nozzles	• Cutting tool problems • Observance of tool positions, in accordance with programming • Methods of adjusting the spray nozzles • Reading of cutting tool offsets on: - the machine tool - a pre-set tooling bench • Method of inputting tool offsets using: - the machine tool controller - the program • Determination of type of tool nose orientation • Size of tool corner radius • Adjustment of rapid and machining feed rate as a percentage • Adjustment of rpm as a percentage • Safety devices on the machine tool: - axis lock - spindle lock - emergency stop
6. Validate the program.	6.1 Simulation of toolpaths in accordance with the capacity of the numerical control lathe: - graphic simulation - semi-automatic no-load test - automatic no-load test 6.2 Recognition of the causes of machining incidents when machining the first part 6.3 Verification of conformity of first part with drawing and instructions 6.4 Appropriate corrections made to: - the program - the tool offset	• Graphic simulation of toolpaths • No-load test • Semi-automatic (block by block) and automatic modes • Problem-solving methods • Machining of first part in semi-automatic mode • Adjustment, as needed, of machining parameters after the first part • Adjustment, as needed, of tool offsets after the first part • Frequent errors

Specifications	Performance Criteria	Suggested Related Content
7. Perform external turning operations, such as: - roughing and finishing - facing - parallel turning - grooving - threading - taper turning - chamfering	7.1 Safe start-up of numerical control lathe in automatic mode 7.2 Constant supervision of operations 7.3 Frequent verification of condition of cutting tools and conformity of machined parts 7.4 Appropriate corrections made to: - the machining process - the process sheet 7.5 Confirmation of validity of corrections with the appropriate person 7.6 Proper use of cutting fluids 7.7 Careful deburring and cleaning of parts 7.8 Observance of time limits 7.9 Observance of health and safety rules specific to numerical control lathes	• Techniques for performing the different external turning operations • Observance of procedure for starting up the lathe • Observance of dimensional and geometric tolerances • Detection of abnormal noises • Awareness of wear of cutting tools • Replacement of cutting tools during production • Cleaning and deburring methods • Risk of injury • Preventive measures
8. Control the quality of the machined part.	8.1 Conformity of part with requirements 8.2 Proper use of: - measuring instruments and devices - three-dimensional measuring machine 8.3 Proper presentation of results in reports 8.4 Careful cleaning and storage of measuring devices and instruments	• Direct and indirect measuring instruments • Calibration methods • Specific installations for inspection • Optical comparator • Roughness tester • Other necessary measuring instruments or devices • Inspection sheets and reports

Specifications	Performance Criteria	Suggested Related Content
9. Perform daily maintenance on the machine tool, tools and accessories.	9.1 Proper cleaning and storage of the machine tool, tools and accessories, and proper cleaning of work area 9.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 9.3 Appropriate corrections made 9.4 Appropriate reporting of abnormalities 9.5 Observance of health and safety rules 9.6 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Storage methods • Types of soluble oils • Treatment or replacement of substandard soluble oils • Health risks of contaminated coolants • Types of lubricating oils • Types of hydraulic oils • Types of greases • Detection of abnormal noises • Detection of abnormal vibrations

MODULE 21: MANUAL PROGRAMMING OF A MACHINING CENTRE **CODE: 872 214** **60 HOURS**

HARMONIZATION:
This module is equivalent to Module 6 of *Numerical Control Machine Tool Operation* (AVS) and competency 012W of *Mechanical Engineering Technology* (DEC).

Expected Behaviour	Conditions for Performance Evaluation	Suggested Approach
Program a machining centre manually.	• Given: - drawings of simple parts to be machined in metric or imperial units of measurement - process sheets - instructions - industrial numerical control machining centres or milling machines or a microcomputer with a text editor and communication software - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - Tables and nomographs - Technical manuals - Tool catalogues - programming manuals • Following occupational health and safety rules	• Have the students write programs in both the metric and the imperial systems of measurement. • Demand serious, careful work. • Provide students with individualized support. • Mounting techniques and cutting technology will be dealt with in more detail in subsequent modules. • In order to better integrate the learning in manual programming, this module should be taught concurrently with the competency *Machine simple parts using a machining centre*.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings, process sheet and manuals, the information needed for the job.	1.1 Thorough identification of information needed for the job 1.2 Accurate interpretation of information 1.3 Accurate identification of reference surfaces 1.4 Accurate English and French terminology	• Dimensions (length, diameter, radius, angle, etc.) • Tolerance limits: - international standards - American standards - dimensional, form and positioning tolerances • Surface finishes • Basic symbols and symbols specific to numerical control • Reference surfaces and surfaces to be machined • Conventional and absolute dimensioning • Characteristics of a numerical control machining centre or milling machine (e.g. capacity) • Productivity and quality resulting from the sequence of operations
2. Write the program.	2.1 Proper choice of zero position of workpiece 2.2 Accurate calculation of rectangular and polar coordinates, as needed 2.3 Determination of position of beginning and end of toolpath 2.4 Structured development of program 2.5 Accurate insertion of machining parameters: - rpm - feed rate in units per minute 2.6 Conformity with process sheet 2.7 Observance of programming syntax	• Systems of axes specific to numerical control machining centres or milling machines • Incremental and absolute methods • Method of calculating average dimensions • Programming design: - position of tool at each point of intersection - zero position - toolpaths • Metric and imperial systems of measurement • Preparatory, miscellaneous and information functions • Canned and fixed cycles • Cutter compensation • Translation of toolpaths into machine language • Other

Specifications	Performance Criteria	Suggested Related Content
3. Edit the program using: - a microcomputer - the machine tool controller	3.1 Observance of procedure according to equipment used: - data entry - data archiving - data transmission 3.2 Inclusion of all program data 3.3 Accurate data entered	• Editing method using a microcomputer with a text editor • Editing method using the machine tool controller • Method of archiving data: - hard disk - diskette - cassette - tape - other • Method of transmitting data using different media
4. Validate the program.	4.1 Conformity of program with drawing and instructions 4.2 Detailed simulation of toolpaths: - graphic simulation - no-load test 4.3 Detection of programming errors 4.4 Appropriate corrections made 4.5 Observance of archiving method 4.6 Observance of time limits	• Method of graphic simulation • Method of no-load testing of program on machine tool controller without graphic simulator • Problem-solving methods • Frequent errors

MODULE 22: BASIC MACHINING USING A MACHINING CENTRE — CODE: 872 226 — 90 HOURS

HARMONIZATION:
This module is equivalent to Module 7 of *Numerical Control Machine Tool Operation* (AVS). The content of Modules 20 and 22 of this program is equivalent to competency 012V of *Mechanical Engineering Technology* (DEC).

Expected Behaviour	Conditions for Performance Evaluation	Suggested Approach
Machine simple parts using a machining centre.	• Given: - drawings of parts requiring machining operations on a milling machine, in metric and imperial units of measurement - instructions - materials with a high machinability rating - industrial numerical control machining centres or milling machines (programming could also be done using a microcomputer with a text editor and communication software) - conventional carbide and new types of high performance cutting tools - testing instruments and apparatus (including a three-dimensional measuring machine) - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues - programming manuals • Following occupational health and safety rules	• Have the students write programs in both the metric and imperial systems of measurement. • Demand serious, careful work. • Provide students with individualized support. • Devote 10 percent of teaching time to mounting methods and cutting tools used on numerical control milling machines and machining centres. • Perform manual operations on the numerical control milling machine or machining centre at the very beginning of the module. • Machine the first part using a program written by the instructor. • Set up the process sheet, installations and programming for mass production. • At this stage of the program, use drawings with a minimum of geometric tolerances. • The projects to be done should gradually increase in complexity. • In order to better integrate the learning in basic machining, this competency should be taught concurrently with the competency *Program a numerical control machining centre manually*. • Use both incremental and absolute programming methods. • Apply concepts of self-inspection to numerical control.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings and manuals, the information needed for the job.	1.1 Thorough identification of information needed for the job 1.2 Accurate interpretation of information 1.3 Accurate identification of reference surfaces 1.4 Accurate English and French terminology	• Dimensions (length, diameter, radius, angle, etc.). • Tolerance limits: - international standards - American standards • Dimensional, form and positioning tolerances • Surface finishes • Basic symbols and symbols specific to numerical control • Reference surfaces and surfaces to be machined • Conventional and absolute dimensioning • Annotations • Consultation of reference tables

Specifications	Performance Criteria	Suggested Related Content
2. Develop the process sheet.	2.1 Determination of logical sequence of machining operations 2.2 Selection of machine tool in accordance with: - its capacity - the machining operations required 2.3 Choice of mounting methods in accordance with: - the material to be machined - the machining operations required - the machining precision required 2.4 Proper identification of support and clamping points 2.5 Choice of cutting tools and mounting methods in accordance with: - their machining capacity - the material to be machined - the machining operations required - the capacity of the machine tool - the surface finishes - the optimization of the process 2.6 Proper choice of testing instruments and apparatus 2.7 Verification of availability of machine tool, accessories, cutting tools, measuring instruments and testing apparatus 2.8 Determination of machining parameters 2.9 Careful sketch of workpiece in machining position	• Characteristics of numerical control milling machines and machining centres • Productivity and quality resulting from the sequence of operations • Types of installation in accordance with the machining operation and the shape of the workpiece • Characteristics of a proper installation • Safety rules related to installation • Cutting tools and tool holders specific to numerical control milling machines and machining centres • Machining conditions: - minimum of chips - wear and useful life of tools - necessary power - other • Applications of cutting fluids • Awareness of physical phenomena that occur during machining: - bending - vibration (resonance) • Calculation of machining parameters in accordance with the information in the manufacturers' tool catalogues • Use of tables and nomographs • Direct and indirect measuring instruments • Testing apparatus • Mounting accessories specific to numerical control milling machines and machining centres • Quality of surface finish in accordance with feed and type of tool

Specifications	Performance Criteria	Suggested Related Content
3. Program the machining centre.	3.1 Accurate calculation of rectangular and polar coordinates 3.2 Proper choice of zero position of workpiece 3.3 Determination of toolpaths 3.4 Proper translation of toolpaths into machine language 3.5 Conformity with process sheet 3.6 Proper editing of program using: - a computer - the machining centre controller 3.7 Thorough verification of presence and accuracy of program data	• Systems of axes specific to numerical control milling machines: - system of machine axes - system of axes of the workpiece • Incremental and absolute methods • Program design: - position of tool at each point of intersection - zero position of workpiece - toolpaths • Metric and imperial systems of measurement • Use of a scientific calculator • Preparatory, miscellaneous and information functions • Canned and fixed cycles • Cutter compensation • Editing using a microcomputer with a text editor or the machine tool controller • Method of archiving data • Transmission of data using different media
4. Mount the workpiece on the machining centre.	4.1 Visual and manual inspection of machine tool and mounting accessories 4.2 Appropriate corrections made 4.3 Proper installation of mounting accessories on machining centre 4.4 Proper positioning and alignment of workpiece 4.5 Safe installation of workpiece on machining centre	• Characteristics of a proper installation • Handling of workpiece and mounting accessories • Condition and maintenance of accessories • Alignment of: - vice - jig - workpiece • Method of mounting accessories • Position and orientation of workpiece • Clamping technique and effect on workpiece • Other

Specifications	Performance Criteria	Suggested Related Content
5. Prepare the machining centre.	5.1 Visual and manual inspection of accessories and cutting tools 5.2 Appropriate corrections made 5.3 Proper installation of cutting tools 5.4 Proper adjustment of tool offsets, feed rates, cutting speeds and spray nozzles	• Cutting tool problems • Methods of adjusting the spray nozzles • Reading of cutting tool offsets on: - the machine tool - a pre-set tooling bench • Method of inputting tool offsets using: - the machine tool controller - the program • Method of determining the zero position of the workpiece • Size of tool corner radius for roughing and finishing • Adjustment of rapid and machining feed rate as a percentage • Adjustment of rpm as a percentage • Safety devices on the machine tool: - axis lock - spindle lock - emergency stop
6. Validate the program.	6.1 Proper simulation of toolpaths in accordance with the capacity of the machining centre: - graphic simulation - semi-automatic no-load test - automatic no-load test 6.2 Recognition of the causes of incidents during machining of the first part 6.3 Verification of conformity of first part with drawing and instructions 6.4 Appropriate corrections made to: - the program - the tool offset	• Graphic simulation of toolpaths • No-load test • Semi-automatic (block by block) and automatic modes • Problem-solving methods • Machining of first part in semi-automatic mode • Adjustment, as needed, of machining parameters after the first part • Adjustment, as needed, of tool offsets after the first part • Frequent errors

Specifications	Performance Criteria	Suggested Related Content
7. Perform machining operations using the machining centre, such as: - contouring - facing - centre drilling - drilling - reaming - facing - grooving - counterboring - tapping	7.1 Safe start-up of machining centre in automatic mode 7.2 Constant supervision of operations 7.3 Frequent verification of condition of cutting tools and conformity of machined parts 7.4 Appropriate corrections made to: - the machining process - the process sheet 7.5 Confirmation of validity of corrections with the appropriate person 7.6 Proper use of cutting fluids 7.7 Careful deburring and cleaning of parts 7.8 Observance of time limits 7.9 Observance of health and safety rules specific to machining centres	• Techniques for performing the different machining operations on a numerical control milling machine or machining centre • Straight and curved contouring • Circular and rectangular recesses • Observance of procedure for starting up the machine tool • Observance of dimensional and geometric tolerances • Detection of abnormal noises • Awareness of wear of cutting tools • Replacement of cutting tools during production • Cleaning and deburring methods • Risk of injury • Preventive measures
8. Control the quality of the machined part.	8.1 Conformity of part with requirements 8.2 Proper use of: - measuring instruments and devices - three-dimensional measuring machine 8.3 Proper presentation of results in reports 8.4 Careful cleaning and storage of measuring devices and instruments	• Direct and indirect measuring instruments • Calibration methods • Specific installations for inspection • Optical comparator • Roughness tester • Other necessary measuring instruments or devices • Inspection sheets and reports

Specifications	Performance Criteria	Suggested Related Content
9. Perform daily maintenance on the machining centre, tools and accessories.	9.1 Proper cleaning and storage of the machine tool, tools and accessories, and proper cleaning of work area 9.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 9.3 Appropriate corrections made 9.4 Appropriate reporting of abnormalities 9.5 Observance of health and safety rules 9.6 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Storage methods • Types of soluble oils • Treatment or replacement of substandard soluble oils • Health risks of contaminated coolants • Types of lubricating oils • Types of hydraulic oils • Types of greases • Detection of abnormal noises • Detection of abnormal vibrations

MODULE 23: COMPLEX TURNING OPERATIONS		CODE: 872 238 120 HOURS
Expected Behaviour	**Conditions for Performance Evaluation**	**Suggested Approach**
Perform complex turning operations.	• Given: - drawings of parts requiring complex machining in metric or imperial units of measurement - instructions - ferrous or non-ferrous materials or materials such as polymers and composites, bar and other types of stock and materials with a low machinability rating - conventional horizontal lathes and their accessories - regularly or irregularly shaped conventional and new types of rapid steel or carbide tools - testing instruments and apparatus, including a three-dimensional measuring machine - products - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues • Following health and safety rules	• Encourage the students to use new types of cutting tools. • Provide the students with complex drawings including fit tolerances. • Have the students sharpen form tools. • At this point in the program, the students must design their own process sheet and explain their choices.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings and manuals, the information needed for the job.	1.1 Thorough identification of information needed for the job 1.2 Accurate interpretation of information 1.3 Accurate identification of reference surfaces 1.4 Accurate English and French terminology	• Detail drawings in metric and imperial units of measurement • Symbols • Codes • Materials • Dimensioning

Specifications	Performance Criteria	Suggested Related Content
2. Develop the process sheet.	2.1 Determination of logical sequence of machining operations 2.2 Choice of lathe in accordance with: - its capacity - the machining operations required 2.3 Choice of mounting methods in accordance with: - the physical constraints of the material to be machined - external turning and boring operations - high machining precision 2.4 Proper identification of support and clamping points 2.5 Choice of cutting tools and mounting methods in accordance with: - the complexity of the task - materials with specific physical constraints - external turning and boring operations - the capacity of the lathe - difficult surface finishes - the optimization of the process 2.6 Proper choice of instruments and devices for very precise dimensional inspection 2.7 Verification of availability of lathe, accessories, cutting tools, measuring instruments and testing apparatus needed for advanced turning 2.8 Determination of parameters related to materials presenting specific machining difficulties 2.9 Careful sketch of workpiece in machining position	• Routines, subroutines and operations • Productivity and quality resulting from the sequence of operations • Components of the lathe • Condition and capacity of the lathe: length between centres, turning diameter, accessories, rpm, feed and increment • Isostasy • Characteristics of a proper installation • Safety rules applicable to installation • Cutting tools: material and grade, physical characteristics and heat effects of cut • Geometry of cutting tools and terminology: angles, radii, chip breaker, shapes and sizes • Calculation of cutting parameters: rpm, feed rate and depth of cut • Physical constraints of materials: fragile parts, parts with thin walls, parts with a low machinability rating, etc. • Use of tables and nomographs • Travel coordinates: machining allowance and polar coordinates • Measuring instruments in metric and imperial units of measurement: rulers, vernier calliper, micrometer callipers, dial gauge, protractor, dividers, etc. • Testing apparatus: three-dimensional measuring machine, parallels, gauge blocks, V blocks, sine bar, etc. • Isostatic symbols (support, clamping, etc.), dimensioning and highlighting of surfaces to be machined

Specifications	Performance Criteria	Suggested Related Content
3. Lay out parts.	3.1 Proper inspection of: - condition of part and its conformity with drawing - surface plate - layout instruments - mounting accessories 3.2 Appropriate corrections made 3.3 Careful preparation of surfaces 3.4 Proper positioning of workpiece 3.5 Observance of techniques for laying out: - parallel - angular - curvilinear 3.6 Layout in conformity with drawing and operations to be performed 3.7 Definitive layout of lines using a prick punch	• Characteristics of castings • Deburring techniques • Layout instruments • Mounting and fastening accessories • Application of layout dye • Mounting methods • Cleaning products and their use • Layout methods • Techniques for sharpening scribers and dividers
4. Mount the workpiece on the lathe.	4.1 Visual and manual inspection of lathe and mounting accessories 4.2 Appropriate corrections made 4.3 Mounting of accessories in accordance with the type of installation: - machined three-jaw chucks - four-jaw chucks - steady rest and follower rest - table - jig 4.4 Proper positioning and alignment of workpiece in accordance with its dimensional constraints 4.5 Safe installation of workpiece on lathe in accordance with its physical constraints	• Characteristics of a proper installation • Handling of workpiece and mounting accessories • Condition and maintenance of accessories • Alignment of tailstock and jig • Method of mounting accessories • Orientation of workpiece • Clamping technique and effect on workpiece • Soft jaw machining technique • Adjustment of rests

Specifications	Performance Criteria	Suggested Related Content
5. Prepare the lathe and the work station.	5.1 Visual and manual inspection of cutting tools, measuring instruments and accessories 5.2 Appropriate corrections made 5.3 Proper positioning and mounting of cutting tools 5.4 Adjustments in conformity with process sheet: - feed rate - rpm - compound rest 5.5 Organized arrangement of instruments 5.6 Observance of health and safety rules	• Inspection of cut • Sharpening and replacement of tip • Adjustment of tool height • Orientation of tool • Proper mounting of tool • Verification of availability of testing, calibration and adjustment instruments
6. Perform complex turning operations, such as: - turning of long workpieces - external and internal taper turning - internal and external eccentric turning - turning using a jig - concave and convex turning - form grooving	6.1 Conformity with process sheet 6.2 Observance of roughing and finishing techniques in accordance with the type of operation performed 6.3 Accurate identification of machining problems 6.4 Appropriate corrections made to: - the machining process - the process sheet 6.5 Confirmation of validity of corrections with the appropriate person 6.6 Proper use of cutting fluids and coolants 6.7 Machining in conformity with drawings 6.8 Careful deburring and cleaning of part 6.9 Observance of time limits 6.10 Observance of health and safety rules	• Movements of carriage and follower rest • Increments • Effects of cut on workpiece: thermal expansion and deformation • Methods of using cutting fluids and coolants • Techniques for performing the different operations, including roughing and finishing • Inspection during the machining process: dimensional, form and positioning tolerances, and roughness index • Deburring techniques • Health and safety rules

Specifications	Performance Criteria	Suggested Related Content
7. Control the quality of the machined part.	7.1 Conformity of part with requirements 7.2 Proper use of: - measuring instruments and devices - three-dimensional measuring machine 7.3 Proper presentation of results in reports 7.4 Careful cleaning and storage of measuring devices and instruments	• Inspection of linear and angular dimensions, form and positioning tolerances, and surfaces • Direct and indirect measuring instruments • Other necessary inspection devices or instruments, including a three-dimensional measuring machine and a roughness tester • Calibration and adjustment • Inspection sheets and reports • Concepts of self-inspection
8. Perform regular maintenance on the lathe, accessories and cutting tools.	8.1 Proper cleaning and storage of the machine tool, tools and accessories, and proper cleaning of work area 8.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 8.3 Appropriate corrections made 8.4 Lubrication by hand at the appropriate points 8.5 Appropriate reporting of abnormalities 8.6 Observance of health and safety rules 8.7 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Lubrication methods • Types of lubricants: soluble oils, lubricating oils, hydraulic oils and greases • Lubrication points • Treatment or replacement of substandard soluble oils • Health risks associated with contaminated coolants • Disposal of used oil • Detection of abnormal vibrations and noises • Criteria related to cleanliness

MODULE 24: COMPLEX MILLING OPERATIONS		CODE: 872 248 120 HOURS
Expected Behaviour	**Conditions for Performance Evaluation**	**Suggested Approach**
Perform complex milling operations.	• Given: - drawings of parts requiring complex machining in metric or imperial units of measurement - instructions - ferrous or non-ferrous materials or different types of materials, such as polymers or composites, bar and other types of stock and materials with a low machinability rating - conventional horizontal or vertical milling machines and their accessories - regularly or irregularly shaped conventional and new types of rapid steel or carbide tools - testing instruments and apparatus, including a three-dimensional measuring machine - products - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues • Following health and safety rules	• Encourage the students to use new types of cutting tools. • Provide the students with complex drawings including fit tolerances. • Have the students sharpen form tools. • At this point in the program, the students must design their own process sheet and explain their choices.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings and manuals, the information needed for the job.	1.1 Thorough identification of information needed for the job 1.2 Accurate interpretation of information 1.3 Accurate identification of reference surfaces 1.4 Accurate English and French terminology	• Detail drawings in metric and imperial units of measurement • Symbols • Codes • Materials • Dimensioning

Specifications	Performance Criteria	Suggested Related Content
2. Develop the process sheet.	2.1 Determination of logical sequence of machining operations 2.2 Choice of milling machine in accordance with: - its capacity - the machining operations required 2.3 Choice of mounting methods in accordance with: - the physical constraints of the material to be machined - the milling operations required - high machining precision 2.4 Proper identification of support and clamping points 2.5 Choice of cutting tools and mounting methods in accordance with: - the complexity of the task - materials with specific physical constraints - the milling operations required - the capacity of the milling machine - difficult surface finishes - the optimization of the process 2.6 Proper choice of instruments and devices for very precise dimensional inspection 2.7 Verification of availability of milling machine, accessories, cutting tools, measuring instruments and testing apparatus needed for complex milling operations 2.8 Determination of parameters related to materials presenting specific machining difficulties 2.9 Careful sketch of workpiece in machining position	• Routines, subroutines and operations • Productivity and quality resulting from the sequence of operations • Components of the milling machine • Condition and capacity of the milling machine and its accessories: clamping area, movements along the x, y and z axes, rpm, feed, increments, spindle cone, etc. • Isostasy • Characteristics of a proper installation • Safety rules applicable to installation • Cutting tools: material and grade, physical characteristics and heat effects of cut • Geometry of cutting tools and terminology: angles, radii, chip breaker, shapes and sizes • Calculation of cutting parameters: rpm, feed rate and depth of cut • Physical constraints of materials: fragile parts, parts with thin walls, parts with a low machinability rating, etc. • Use of tables and nomographs • Travel coordinates: machining allowance and polar coordinates • Measuring instruments in metric and imperial units of measurement: rulers, vernier calliper, micrometer callipers, dial gauge, protractor, dividers, etc. • Testing apparatus: three-dimensional measuring machine, parallels, gauge blocks, V blocks, sine bar, etc. • Isostatic symbols (support, clamping, etc.), dimensioning and highlighting of surfaces to be machined

Specifications	Performance Criteria	Suggested Related Content
3. Lay out parts.	3.1 Proper inspection of: - part - surface plate - layout instruments - mounting accessories 3.2 Appropriate corrections made 3.3 Careful presentation of surfaces 3.4 Proper positioning of workpiece 3.5 Observance of techniques for laying out: - parallel - angular - curvilinear 3.6 Layout in conformity with drawing and operations to be performed 3.7 Definitive layout of lines using a prick punch	• Characteristics of the castings • Deburring techniques • Layout instruments and techniques for their use • Mounting accessories and their use • Use of cleaning and etching products • Deburring and punching techniques

Specifications	Performance Criteria	Suggested Related Content
4. Mount the workpiece on the milling machine.	4.1 Visual and manual inspection of milling machine and mounting accessories 4.2 Appropriate corrections made 4.3 Proper mounting of accessories, in accordance with the type of installation: - Vice - angle plate - jig - chuck - V block - indexing attachment - rotary table - directly on the table 4.4 Proper positioning and alignment of workpiece in accordance with its dimensional constraints 4.5 Safe installation of workpiece on milling machine in accordance with its physical constraints	• Characteristics of a proper installation • Handling of workpiece and mounting accessories • Condition and maintenance of accessories • Alignment of workpiece and mounting accessories • Method of mounting accessories • Orientation of workpiece • Clamping technique and effect on workpiece
5. Prepare the milling machine and the work station.	5.1 Visual and manual inspection of cutting tools, measuring instruments and accessories 5.2 Appropriate corrections made 5.3 Proper positioning and mounting of cutting tools 5.4 Adjustments in conformity with process sheet - feed rate - rpm - incline of milling head - safety stops 5.5 Organized arrangement of instruments 5.6 Observance of health and safety rules	• Inspection of cut • Sharpening and replacement of tip • Adjustment of tool height • Orientation of tool • Proper mounting of tool • Verification of availability of testing, calibration and adjustment instruments

Specifications	Performance Criteria	Suggested Related Content
6. Perform advanced milling operations, such as: - longitudinal and transverse milling - internal and external angular milling - internal and external circular milling - milling of reference surfaces	6.1 Conformity with process sheet 6.2 Observance of roughing and finishing techniques in accordance with the type of operation performed 6.3 Accurate identification of machining problems 6.4 Appropriate corrections made to: - the machining process - the process sheet 6.5 Confirmation of validity of corrections with the appropriate person 6.6 Proper use of cutting fluids and coolants 6.7 Machining in conformity with drawings 6.8 Careful deburring and cleaning of part 6.9 Observance of time limits 6.10 Observance of health and safety rules	• Movements of table and spindle • Increments • Effects of cut on workpiece: thermal expansion and deformation • Methods of using cutting fluids and coolants • Techniques for performing the different operations, including roughing and finishing • Inspection during the machining process: dimensional, form and positioning tolerances, and roughness index • Deburring techniques • Health and safety rules
7. Control the quality of the machined part.	7.1 Conformity of part with requirements 7.2 Proper use of: - measuring instruments and devices - three-dimensional measuring machine 7.3 Proper presentation of results in reports 7.4 Careful cleaning and storage of measuring devices and instruments	• Inspection of linear and angular dimensions, form and positioning tolerances, and surfaces • Direct and indirect measuring instruments • Other necessary inspection devices or instruments, including a three-dimensional measuring machine and a roughness tester • Calibration and adjustment • Inspection sheets and reports • Concepts of self-inspection

Specifications	Performance Criteria	Suggested Related Content
8. Perform regular maintenance on the milling machine, accessories and cutting tools.	8.1 Proper cleaning and storage of the machine tool, tools and accessories, and proper cleaning of work area 8.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 8.3 Appropriate corrections made 8.4 Lubrication by hand at the appropriate points 8.5 Appropriate reporting of abnormalities 8.6 Observance of health and safety rules 8.7 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Lubrication methods • Types of lubricants: soluble oils, lubricating oils, hydraulic oils and greases • Lubrication points • Treatment or replacement of substandard soluble oils • Health risks associated with contaminated coolants • Disposal of used oil • Detection of abnormal vibrations and noises • Criteria related to cleanliness

MODULE 25: MASS PRODUCTION (OPTIONAL)		CODE: 872 255 75 HOURS
Expected Behaviour	**Conditions for Performance Evaluation**	**Suggested Approach**
Mass-produce parts using conventional machining techniques.	• Working in a team under supervision • Given: - assembly and detail drawings in metric or imperial units of measurement - process sheets - instructions - different types of materials - different conventional machine tools and their accessories (numerical control machine tools may be used on occasion) - conventional and new types of carbide tools - form tools - electronic and conventional testing instruments and apparatus, including a three-dimensional measuring machine, statistical calculators or computers and software - products - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues • In an environment allowing for mass production and the observance of health and safety rules	• The instructor should divide the group into teams and assign tasks. • The students will be responsible for the distribution of tasks within their own team. • The students should have equal access to lathes and milling machines.

Specifications	Performance Criteria	Suggested Related Content
1. Find out about the mass-production project.	1.1 Thorough collection of information about mass production 1.2 Recognition of the components of the object to be made and their characteristics 1.3 Proper choice of drawings and process sheets for each part of the object 1.4 Recognition of the machining operations required to carry out the mass-production project	• Collection and study of documentation on the mass-production project
2. Organize the work team.	2.1 Consensus on team rules 2.2 Proper distribution of machining operations among the work stations, in accordance with the types of processes and optimization of performance 2.3 Efficient sharing of tasks 2.4 Accurate report of decisions made presented to those responsible for production	• Review and application of principles of communication and problem solving related to the organization of work as such, as well as to work in a multidisciplinary team
3. Identify, in the drawings, process sheets and manuals, the information needed for the job.	3.1 Thorough identification of information needed for the job 3.2 Accurate interpretation of information 3.3 Accurate identification of reference surfaces 3.4 Accurate English and French terminology	• Detail drawings in metric and imperial units of measurement • Symbols • Codes • Materials • Dimensioning • Characteristics of machine tools • Constraints related to: - shape of part - materials to be machined

Specifications	Performance Criteria	Suggested Related Content
4. Organize the work stations.	4.1 Verification of availability of materials 4.2 Conformity with process sheets 4.3 Visual and manual inspection of machine tools, tools, accessories, instruments and testing apparatus 4.4 Appropriate corrections made 4.5 Proper installation of tools and accessories 4.6 Safe installation of workpieces on machine tools 4.7 Proper adjustment of machines 4.8 Observance of health and safety rules	• Appropriate mounting accessories for mass production • Adjustment techniques in accordance with the type of machining operation required: - stop - scanner • Appropriate cutting tools and tips for mass production • Type of installation and mounting techniques in accordance with the parts to be made: - jig - soft jaws - other
5. Produce the first parts.	5.1 Observance of techniques 5.2 Safe use of machine tools 5.3 Recognition of the causes of machining incidents 5.4 Complete verification of conformity of first parts with drawings and instructions 5.5 Relevance of decisions made by the team with respect to corrective measures 5.6 Appropriate corrections made	• Adjustment of rpm and feed rate in accordance with the operations required • Adjustment of stops as needed • Maximum use of scanner • Identification of travel coordinates related to sequences of operations • Techniques for using accessories

Specifications	Performance Criteria	Suggested Related Content
6. Perform the machining operations required for mass production.	6.1 Safe use of machine tools 6.2 Constant supervision of operations 6.3 Frequent inspection of cutting tools and machined parts 6.4 Appropriate corrections made 6.5 Complete list of machining incidents 6.6 Proper use of cutting fluids 6.7 Careful deburring and cleaning of parts 6.8 Accurate account of time required for each stage of production	• Handling techniques • Awareness of problems inherent in mass production • Detection of abnormal noises • Maximum use of machining process in accordance with: - machine tool - cutting tools - handling techniques - materials to be machined • Replacement of cutting tools and tips during machining • Observance of dimensional tolerances • Cleaning and deburring methods

Specifications	Performance Criteria	Suggested Related Content
7. Perform statistical quality control tasks.	7.1 Methodical application of a sampling plan 7.2 Proper choice of testing instruments and apparatus 7.3 Verification of conformity of parts with requirements 7.4 Proper use of method of transferring data onto a computer medium 7.5 Brief interpretation of results 7.6 Careful cleaning and storage of testing instruments and apparatus	• Role of statistical quality control in the production process • Role of the machinist in quality control • Terminology related to statistical quality control • Statistical control chart • On-screen display or printing • Better perception of surface flaws and irregularities: undulation, roughness, scratches, cracks, pitting, ridges and depressions • Causes of dispersion of measurements: variation of measurements due to tool wear, incorrect replacement interval for tools, incorrect cutting parameters, poor mounting, poor condition of machine tool, quality criteria in excess of the capacity of the machine tool and the thermal expansion of parts • Use of clean and efficient testing instruments and apparatus in the production process: digital instruments, direct instruments, comparators, callipers, gauge blocks, roughness tester, three-dimensional measuring machine, etc. • Accuracy class of instruments • Inspection sheets and reports
8. Suggest methods for continuous improvement.	8.1 Appropriate timing 8.2 Clear description of production problems 8.3 Determination of causes 8.4 Common definition of team productivity and quality objectives 8.5 Relevant, realistic suggestions 8.6 Openness to different points of view 8.7 Consensus on solution	• Problem solving • Comments or recommendations after consultation of statistical reports and time sheets • Process of decision making by consensus

Specifications	Performance Criteria	Suggested Related Content
9. Perform regular maintenance on the machine tools, accessories and cutting tools.	9.1 Proper cleaning and storage of the machine tools, tools and accessories, and proper cleaning of work area 9.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 9.3 Appropriate corrections made 9.4 Lubrication by hand at the appropriate points 9.5 Appropriate reporting of abnormalities 9.6 Observance of health and safety rules 9.7 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Lubrication methods • Types of lubricants: soluble oils, lubricating oils, hydraulic oils and greases • Lubrication points • Treatment or replacement of substandard soluble oils • Health risks associated with contaminated coolants • Disposal of used oil • Detection of abnormal vibrations and noises • Criteria related to cleanliness

MODULE 26: USING A BORING MACHINE (OPTIONAL)		CODE: 872 265 75 HOURS
Expected Behaviour	**Conditions for Performance Evaluation**	**Suggested Approach**
Perform machining operations using a boring machine.	• Given: - drawings of simple parts to be machined in metric or imperial units of measurement - instructions - bar stock with a high machinability rating or a casting - a conventional boring machine and its accessories - conventional and new types of rapid steel or carbide tools - testing instruments and apparatus, including a three-dimensional measuring machine - products - a scientific calculator • Using various reference materials, such as: - *Machinery's Handbook* - tables and nomographs - technical manuals - tool catalogues • Following health and safety rules	• Encourage the students to use new types of cutting tools. • Provide the students with drawings without fit tolerances appropriate to their level of skill.

Specifications	Performance Criteria	Suggested Related Content
1. Identify, in the drawings and manuals, the information needed for the job.	1.1 Thorough identification of information needed for the job 1.2 Accurate interpretation of information 1.3 Accurate identification of reference surfaces 1.4 Accurate English and French terminology	• Detail drawings in metric and imperial units of measurement • Symbols • Codes • Materials • Dimensioning

Specifications	Performance Criteria	Suggested Related Content
2. Develop the process sheet.	2.1 Determination of logical sequence of machining operations 2.2 Choice of boring machine, in accordance with: - its capacity - the boring operations required 2.3 Choice of mounting methods in accordance with: - the material to be machined - the boring operations required - the machining precision required 2.4 Proper identification of support and clamping points 2.5 Choice of cutting tools and mounting methods in accordance with: - their machining capacity - the material to be machined - the boring operations required - the capacity of the boring machine - the surface finishes - the optimization of the process 2.6 Proper choice of testing instruments and apparatus 2.7 Verification of availability of accessories, tools, measuring instruments and testing apparatus 2.8 Determination of: - machining parameters - travel coordinates 2.9 Careful sketch of workpiece in machining position	• Routines, subroutines and operations • Productivity and quality resulting from the sequence of operations • Components of the boring machine • Condition and capacity of the boring machine and accessories: clamping area, movements along the x, y and z axes, rpm, feed, increments, spindle cone, etc. • Isostasy • Characteristics of a proper installation • Safety rules applicable to installation • Cutting tools: material and grade, physical characteristics and heat effects of cut • Geometry of cutting tools and terminology: angles, radii, chip breaker, shapes and sizes • Calculation of cutting parameters: rpm, feed rate and depth of cut • Use of tables and nomographs • Travel coordinates: machining allowance and polar coordinates • Measuring instruments in metric and imperial units of measurement: rulers, vernier callipers, dial gauges, protractor, dividers, etc. • Testing apparatus: roughness tester, parallels, gauge blocks, V blocks, sine bar, etc. • Isostatic symbols (support, clamping, etc.), dimensioning and highlighting of surfaces to be machined

Specifications	Performance Criteria	Suggested Related Content
3. Mount the workpiece on the boring machine.	3.1 Visual and manual inspection of boring machine and mounting accessories 3.2 Appropriate corrections made 3.3 Installation of accessories in accordance with the mounting method: - angle plate - precision vice - V block - fixture - rotary table 3.4 Proper positioning and alignment of workpiece 3.5 Safe installation of workpiece on boring machine	• Characteristics of a proper installation • Handling of workpiece and mounting accessories • Condition and maintenance of accessories • Alignment of workpiece and mounting accessories • Method of mounting accessories • Orientation of workpiece • Clamping technique and effect on workpiece
4. Prepare the boring machine and the work station.	4.1 Visual and manual inspection of cutting tools, measuring instruments and accessories 4.2 Appropriate corrections made 4.3 Proper positioning and mounting of cutting tools 4.4 Adjustments in conformity with process sheet: - feed rate - rpm - safety stops - position of rotary table 4.5 Organized arrangement of instruments 4.6 Observance of health and safety rules	• Inspection of cut • Sharpening and replacement of tip • Adjustment of tool height • Orientation of tool • Proper mounting of tool • Verification of availability of testing, calibration and adjustment instruments • Arrangement of instruments

Specifications	Performance Criteria	Suggested Related Content
5. Perform machining tasks using a boring machine, such as: - longitudinal and transverse milling - angular milling - grooving - drilling - reaming - tapping	5.1 Conformity with process sheet 5.2 Observance of roughing and finishing techniques in accordance with the type of operation performed 5.3 Safe use of boring machine 5.4 Accurate identification of machining problems 5.5 Appropriate corrections made 5.6 Confirmation of validity of corrections with the appropriate person at the appropriate time 5.7 Proper use of cutting fluids and coolants 5.8 Machining in conformity with drawings 5.9 Careful deburring and cleaning of part 5.10 Observance of time limits	• Kinematic chain of boring machine • Start-up • Movements of tables and spindle • Increments • Effects of cut on workpiece: thermal expansion and deformation • Methods of using cutting fluids and coolants • Techniques for performing the different operations, including roughing and finishing • Inspection during the machining process: dimensional, form and positioning tolerances, and roughness index • Deburring techniques • Health and safety rules
6. Control the quality of the machined part.	6.1 Conformity of part with requirements 6.2 Proper use of: - measuring instruments and devices - three-dimensional measuring machine 6.3 Proper presentation of results in reports 6.4 Careful cleaning and storage of measuring devices and instruments	• Inspection of linear and angular dimensions, form and positioning tolerances, and surfaces • Direct and indirect measuring instruments • Other necessary inspection devices or instruments • Calibration and adjustment • Roughness tester • Concepts of self-inspection

Specifications	Performance Criteria	Suggested Related Content
7. Perform regular maintenance on the boring machine, accessories and cutting tools.	7.1 Proper cleaning and storage of the machine tool, tools and accessories, and proper cleaning of work area 7.2 Careful inspection of cutting fluid, and lubricating and hydraulic oil levels 7.3 Appropriate corrections made 7.4 Lubrication by hand at the appropriate points 7.5 Appropriate reporting of abnormalities 7.6 Observance of health and safety rules 7.7 Disposal of hazardous and toxic waste in conformity with regulations	• Methods of cleaning machine tools • Lubrication methods • Types of lubricants: soluble oils, lubricating oils, hydraulic oils and greases • Lubrication points • Treatment or replacement of substandard soluble oils • Health risks associated with contaminated coolants • Disposal of used oil • Detection of abnormal vibrations and noises

MODULE 27: ENTREPRENEURSHIP		CODE: 872 271 15 HOURS
Expected Outcome	**Instructional Guidelines**	**Suggested Approach**
Explore the possibility of starting their own business. *Specifications:* Recognize the conditions favourable to a new project or business. Describe the steps involved in starting a business and the related requirements. Assess their potential and interest regarding entrepreneurship. Find the resources necessary to carry out a project.	• Plan activities likely to interest the students. • Provide the students with relevant documentation (reference manuals, brochures, pamphlets, telephone books, videotapes, etc.). • Invite resource persons to speak. • Provide the students with a list of questions to help them determine their entrepreneurial profile (suggested reference: Desrosiers et al., *Sensibilisation à l'entrepreneurship*, MEQ). • Create a climate conducive to creativity that allows students to explore different entrepreneurial possibilities.	

Learning Context	Participation Criteria	Suggested Related Content
PHASE 1: **Information**	- Gather relevant information on entrepreneurship and the corresponding personality profile.	
• Learning about the role of entrepreneurship in Québec's economic development.		• Social and economic role of individuals and businesses • Market share of small and medium-size businesses in Québec • Global and export markets
• Learning about the available sources of information on starting a business.		• Brochures from government departments, financial institutions, employment centres, etc. • Reference materials on starting a business • Newspapers and magazines specializing in business, economics, etc. • The Internet
• Learning about the personal characteristics of entrepreneurs.		• Determination, patience, perseverance, leadership, courage, honesty, etc. • Ability to communicate, work long hours, manage personnel, face financial difficulties, adapt to change, manage stress, solve problems, etc. • Competencies

Learning Context	Participation Criteria	Suggested Related Content
PHASE 2: **Implementation of Means of Starting a New Project or Business**	- Summarize the steps involved in carrying out a business project. - Establish their entrepreneurial profile.	
• Analyzing the advantages and disadvantages of starting a mechanical manufacturing business.		• Advantages: - job creation - possibility of expansion and diversification - contribution to regional development - self-actualization - management and decision making - other • Disadvantages: - financial investment - risk - responsibilities and the amount of work required - legislation - other
• Reflecting on their entrepreneurial potential.		• Self-knowledge • Aptitudes and attitudes • Abilities • Preferences and interests • Physical stamina • Other

Learning Context	Participation Criteria	Suggested Related Content
• Determining the steps involved in an operating plan.		• Determination of type of business • Choice of form of business organization: - sole proprietorship - partnership - corporation - franchise - cooperative - other • Choice of company name • Market study • Government requirements: - licence and permits - municipal regulations - zoning regulations - business tax, GST, QST - income tax - legislation (consumer protection and health and safety) • Development of the organizational structure of the business • Role and duties of staff • Business hours • Source of funds

Learning Context	Participation Criteria	Suggested Related Content
• Drawing up a list of resources useful when starting a business. • Participating in various activities.		• Financial assistance: - chartered banks and caisses populaires - Business Development Bank of Canada - Ministère de l'Industrie, du Commerce et de la Technologie - Office de la planification et du développement du Québec • Technical assistance: - banks and caisses populaires - chambers of commerce - management consulting firms - Business Development Bank of Canada management consulting service - new business support services - lawyers and notaries - other • Training provided by: - school boards and colleges - chambers of commerce - other • Round-table meetings with entrepreneurs • Viewing of video tapes and discussion on starting a business • Simulated interviews • Readings • Other activities suggested by the instructor

Learning Context	Participation Criteria	Suggested Related Content
PHASE 3: **Evaluation of their ability**	- Weigh the possibility of starting a business and their interest in the project. - Recognize their character traits or personal qualities to emphasize or that need improvement with a view to starting a business.	
• Assessing their potential for starting a business.		• List of positive and negative personality traits • Assessment of: - the advantages of starting a business and the difficulties involved - their interest and abilities with respect to managing a company - their personal entrepreneurial potential • Use of a list of questions

MODULE 28: ENTERING THE WORKFORCE **CODE: 872 286 90 HOURS**

HARMONIZATION:
This module is equivalent to Module 13 of *Numerical Control Machine Tool Operation* (AVS).

Expected Outcome	Instructional Guidelines	Suggested Approach
Enter the workforce. *Specifications*: Find a practicum position. Observe and perform trade-related tasks in the workplace. Communicate with the work team. Evaluate their training with respect to their observations during the practicum.	• Provide the students with the necessary means and assistance to find a practicum position. • Maintain close ties between the school and the company. • Make sure that the trainees receive the support and supervision of a responsible person in the company. • Ensure the regular support and supervision of students and intervene only in the case of difficulties. • Make sure that the company respects the conditions required for the students to attain the objectives of the practicum. • Encourage the students to engage in discussions and express themselves. • Provide the students with an outline for the report.	

Learning Context	Participation Criteria	Suggested Related Content
PHASE 1: **Search for a Practicum Position**	- List in order of priority possible practicum positions that meet their selection criteria. - Meet with a representative of the company in order to obtain a practicum position.	
• Learning about the practicum and the related procedures.		• Objectives of the practicum • Duration • Instructional guidelines • Participation criteria
• Defining their expectations and needs with respect to the practicum.		• Personal and occupational goals and objectives • Criteria for selecting the company, such as: - size and location - type of production - structure • Quality of working relations • Possibility of attaining the objectives of the practicum • Criteria meeting expectations
• Finding companies likely to meet their expectations and needs.		• Various sources: - banks of companies - telephone books - employment centres - want ads • List of companies who have accepted trainees in the past and related experiences • Instructor's assistance • Classification of companies by type of product or process

Learning Context	Participation Criteria	Suggested Related Content
• Obtaining a practicum position.		• Introduction by mail, telephone or visit • Agreement on practicum procedure • Presentation to employer of the list of tasks required to pass the practicum • Confirmation of practicum • Demonstration of determination, openness, a positive attitude, availability, etc.
• Ensuring that the practicum procedure is within regulations.		• Elements to confirm: - insurance - registration of trainee with the CSST - agreements with unions - responsibilities of parties - other • Agreements on supervision (by the company and the instructor)
PHASE 2: **Performance of Activities in the Workplace**	- Follow company rules regarding activities, work schedules and professional ethics. - Write a practicum report on the activities performed. - Demonstrate interest throughout the activity.	
• Performing various trade-related tasks or participating in their performance.		• Active participation in tasks • Observance of health and safety rules • Observance of company rules and regulations: order, schedules, attendance, movements in the shop and clothing • Behaviour: attentiveness, respect, tact, discretion, concern for excellence, demonstration of interest in all new work experiences, etc.

Learning Context	Participation Criteria	Suggested Related Content
• Communicating with members of the work team and those responsible for the practicum.		• Search for information (desire to learn) • Transmission of information • Positive, open attitude • Acceptance of advice and comments • Feedback • Verification of satisfaction of the person responsible for the practicum • Other
• Producing a report on the tasks and operations performed during the practicum.		• Content of the practicum report: - general information on the location and date of the practicum and on those responsible in the company and the school - description of tasks performed • Machining processes performed, new types of equipment used, new tools, etc. • Problems that occurred and solutions that were applied • Comments on the practicum procedure • Appreciation of tasks • Elements different from those presented at school • Daily report

Learning Context	Participation Criteria	Suggested Related Content
PHASE 3: **Evaluation of the Practicum and of the Training Received**	- Participate in discussions on their experience and on the tasks and operations performed during the practicum. - Emphasize the strong and weak points of the training received.	
• Sharing opinions with other students on their experience and on the tasks and operations performed in the workplace.		• Presentation of the main elements of their report in a group discussion
• Assessing the relevance of their training with respect to the requirements of the workplace.		• List of aspects of the trade that correspond to the training received and those that do not • Comparison of their perception of the trade before and after the practicum • Workplace • Occupational practices • Equipment • Other
• Stating the specific and complementary training needs in machining techniques.		• Extension courses • Specialization courses • Further training

Éducation

Québec

17-1110-01A