MECHANICAL MANUFACTURING

TOOLMAKING

PROGRAM OF STUDY

5542

VOCATIONAL and TECHNICAL EDUCATION

020801
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Québec

TOOLMAKING

PROGRAMME OF STUDY
5542

Gouvernement du Québec
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MECHANICAL MANUFACTURING

TOOLMAKING

PROGRAM OF STUDY
5542

The *Toolmaking* program leads to
the Attestation of Vocational Specialization (AVS)
and prepares the student to practise the trade of

TOOLMAKER

Direction générale de la formation professionnelle et technique

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INTRODUCTION

The *Toolmaking* program is based on the orientations for secondary school vocational education adopted by the government in 1986. It was designed on the basis of a new 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, which are organized into teaching blocks. 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.

The program of study lists the competencies that are the minimum requirements for an Attestation of Vocational Specialization (AVS) for students in both the youth and adult sectors. It also provides the basis for organizing courses, planning teaching strategies, and designing instructional and evaluation materials.

The duration of the program is 900 hours, which includes 540 hours spent on the specific competencies required to practise the trade and 360 hours on general competencies. The program of study is divided into 19 modules, which 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.

This 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.

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

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.

Operational Objectives

Statements of the educational aims of a program in practical terms. They serve as the basis for teaching, learning and evaluation.

Competency

A set of socio-affective behaviours, cognitive skills or psycho-sensori-motor skills that enable a person to correctly perform a role, function, activity or task.

Module of a Program

A component part of a program of study comprising a first-level operational objective and the related second-level operational objectives.

General Objectives

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

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: 19
Duration in hours: 900
Credits: 60

Toolmaking
CODE: 5542

CODE	TITLE OF THE MODULE	HOURS	CREDITS*
866 481	1. The Trade and the Training Process	15	1
866 312	2. Mathematics Applied to Tool and Die Making	30	2
866 323	3. Jig Boring and Jig Grinding	45	3
866 332	4. Metallurgy Applied to Production Machinery	30	2
866 492	5. Metrology Applied to Jigs	30	2
866 503	6. Techniques for Assembling Jigs	45	3
866 512	7. Functional Study of a Machine Tool	30	2
866 525	8. Making a Drill Jig	75	5
866 421	9. Communication in the Workplace	15	1
866 532	10. Analyzing a Jig Drawing	30	2
866 546	11. Making a Lathe Jig	90	6
866 371	12. Machining Materials with Low Machinability Ratings	15	1
866 392	13. Spark Erosion Machining	30	2
866 558	14. Making a Milling Jig	120	8
866 412	15. Surface Grinding Irregular Shapes	30	2
866 432	16. Grinding Irregular Shapes on a Cylindrical Grinder	30	2
866 564	17. Making Gauges	60	4
866 456	18. Entering the Labour Market	90	6
866 576	19. Making a Cutting Tool	90	6

* 15 hours = 1 credit
This program leads to an AVS in Toolmaking.

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2. PROGRAM TRAINING GOALS

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

To develop effectiveness in the practice of a trade.

- To teach students to perform toolmaking 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 skills and techniques needed to make sound decisions on the job;
  - the development of a concern for effective communication with superiors and colleagues;
  - the development of professional ethics and a sense of responsibility;
  - habits of order, cleanliness and precision in the practice of the trade;
  - a constant concern for occupational health and safety.

To ensure integration into the job market.

- To familiarize students with the job market in general and the trade of toolmaker in particular.

- To familiarize students with their rights and responsibilities as workers.

To foster personal development and the acquisition of occupational knowledge.

- To foster independence, a sense of responsibility and the desire to succeed.

- To help students develop the desire for excellence and the basic attitudes required for success.

- To help students understand the principles underlying the techniques used.

- To help students acquire good work habits and a sense of discipline.

To ensure job mobility.

- To help students develop a positive attitude toward technological change and new situations.

- To help students increase their ability to learn and find information.

3. COMPETENCIES

The competencies to be developed in the *Toolmaking* program 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 (○) indicates a correlation between a general and a specific competency.

The symbols (▲) and (●) 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.

GRID OF LEARNING FOCUSES IN *TOOLMAKING*

SPECIFIC COMPETENCIES (directly related to the practice of the specific occupation)		FIRST-LEVEL OPERATIONAL OBJECTIVES	DURATION (IN HOURS)	WORK PROCESS (major steps)												GENERAL COMPETENCIES (related to technology, subjects, personal development, etc.)													TOTALS	
				Read and interpret the drawing for the assembly or the tool	Determine and draw the parts and tools required for manufacture	Give instructions and test machined parts	Machine complex parts on specialized machine tools	Grind the part after heat treatment	Finish the parts	Plan the assembly	Make the subassemblies	Do a test without load or produce a sample	Study the components and kinematic chain of the machine tool	Mount the tool on the production machine	Make the final adjustments to the tool and the production machine	Apply concepts of mathematics to the manufacture of production machinery	Use jig boring and jig grinding	Apply the concepts of metallurgy to the manufacture of production machinery	Apply concepts of metrology to the production of jigs	Apply techniques for assembling jigs	Do a functional study of a machine tool	Communicate in the workplace	Analize the construction of a production jig in a drawing	Apply knowledge related to the machining of materials with low machinability ratings	Do a spark erosion machining operation	Grind a workpiece with complex, irregular shapes on a surface grinder	Grind a workpiece with complex, irregular shapes on a cylindrical grinder	Apply occupational health and safety rules	NUMBER OF OBJECTIVES	DURATION (IN HOURS)
MODULES																2	3	4	5	6	7	9	10	12	13	15	16			
FIRST-LEVEL OCCUPATIONAL OBJECTIVES																B	B	B	B	B	B	S	B	B	B	B	B		12	
DURATION																30	45	30	30	45	30	15	30	15	30	30	30			360
1	Determine their suitability for the trade and the training process	S	15	△	△	△	△	△	△	△	△	△	△	△	△	○	○	○	○	○	○	○	○	○	○	○	○			
8	Manufacture, assemble and adjust a drill jig	B	75	▲	▲	△	▲	△	▲	▲	▲	▲	△	▲	▲	●	●	●	●	●	○	○	○	○		○	○			
11	Manufacture, assemble and adjust a lathe jig	B	90	▲	▲	▲	▲	▲	▲	▲	▲	▲	△	▲	▲	●	●	●	●	●	○	○	●	●		○	○			
14	Manufacture, assemble and adjust a milling jig	B	120	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	●	●	●	●	●	●	○	●	●	●	●	○			
17	Manufacture, assemble and adjust gauges	B	60	▲	▲	▲	▲	▲	▲	▲	▲	△	△	△	▲	●	●	●	●	●	○	○	●	●		●	●			
18	Enter the labour market in toolmaking	S	90	△	△	△	△	△	△	△	△	△	△	△	△	○	○	○	○	○	○	○	○	○	○	○	○			
19	Manufacture, assemble and adjust a cutting tool	B	90	▲	▲	▲	▲	▲	▲			▲	△	▲	▲	●	○	●	●	●	○	○	●	●		●	●			
NUMBER OF OBJECTIVES		7																											19	
DURATION (IN HOURS)			540																											900

S: Situational objective

B: Behavioural objective

△ 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 *Toolmaking* program are presented below, along with the major statement of each corresponding first-level operational objective.

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.
- Enter the labour market in toolmaking.

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

- Manufacture, assemble and adjust a drill jig.
- Manufacture, assemble and adjust a lathe jig.
- Manufacture, assemble and adjust a milling jig.
- Manufacture, assemble and adjust gauges.
- Manufacture, assemble and adjust a cutting tool.

To develop in the students the competencies required to work with metals.

- Apply concepts of metallurgy to the manufacture of production machinery.
- Apply knowledge related to the machining of materials with low machinability ratings.

To develop in the students the competencies required to grind and assemble production tools.

- Use jig boring and jig grinding techniques.
- Grind a workpiece with complex, irregular shapes on a surface grinder.
- Grind a workpiece with complex, irregular shapes on a cylindrical grinder.
- Apply techniques for assembling jigs.

To develop in the students the basic competencies required to practise the trade of toolmaker.

- Apply concepts of mathematics to the manufacture of production machinery.
- Analyze the construction of a production jig in a drawing.
- Apply concepts of metrology to the production of jigs.
- Communicate in the workplace.

To develop in the students the competencies required to use electro-erosion machining techniques and to operate production machines.

- Do a spark erosion machining operation.
- Do a functional study of a machine tool.

5. FIRST- AND SECOND-LEVEL OPERATIONAL OBJECTIVES

5.1 DEFINITION

A first-level 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.

First-level 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. Output and results vary from one student to another. Evaluation is based on the student's participation in the activities of the learning context.

Second-level operational objectives are intermediate teaching/learning targets deemed prerequisite for attaining first-level objectives. They are grouped according to the specifications (see 5.2 A) or the phases (see 5.2 B) of the first-level objective.

The division of operational objectives into first- and second-level objectives is based on a clear distinction between the levels of learning:

- learning involving prerequisite knowledge

- learning involving competencies

Second-level operational objectives indicate prerequisite knowledge. They prepare the students to learn what is necessary to attain the first-level operational objectives, which collectively lead to the development of a competency. The objectives should always be adapted to meet the particular needs of the individual students or groups of students.

First-level operational objectives cover the learning students must acquire to develop a competency:

- The specifications or the phases of the objective determine or guide specific learning, thereby allowing the competency to be developed step by step.

- The objective as a whole (i.e. the six components and in particular the last phase of a situational objective, see 5.2) determines or guides the overall learning and the integration and synthesis of this learning, allowing the competency to be developed fully.

To attain the objectives, the following learning activities may be prepared:

- specific learning activities for second-level objectives
- specific learning activities for the specifications or phases of first-level objectives
- general learning activities for first-level objectives

5.2 HOW TO READ FIRST-LEVEL OPERATIONAL OBJECTIVES

A. How to Read a Behavioural Objective

Behavioural objectives consist of six components. The first three provide an overview of the objective:

1. 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.

2. The **conditions for performance evaluation** define what is necessary or permissible to the students during evaluation designed to verify whether or not the students have attained the objective. This means that the conditions for evaluation are the same wherever and whenever the program is taught.

3. The **general performance criteria** define the requirements by which to judge whether or not the results obtained are generally satisfactory.

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

4. The **specifications of the expected behaviour** describe the essential elements of the competency in terms of specific behaviours.

5. 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.

6. 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:

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

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

3. 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

4. The **instructional guidelines** provide suggested ways and means of teaching the course to ensure that learning takes place and that the same conditions apply wherever and whenever the course is taught. These guidelines may include general principles or specific procedures.

5. The **participation criteria** describe the requirements the students must fulfil, which are usually related to each phase of the learning context. 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.

6. **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.

PART II

MODULE 1: THE TRADE AND THE TRAINING PROCESS

CODE: 866 481 **Duration: 15 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
SITUATIONAL OBJECTIVE

EXPECTED OUTCOME

By participating in the required activities of the learning context according to the indicated criteria, the students will be able to
determine their suitability for the trade and the training process.

SPECIFICATIONS

At the end of this module, the students will:

- Be familiar with the nature of the trade.
- Understand the training process.
- Confirm their career choice.

LEARNING CONTEXT

PHASE 1: **Information on the Trade**

- Learning about the job market in toolmaking—work environments (types of companies, products), job prospects, wages, opportunities for advancement and transfer, candidate selection and women workers in the field—through visits, interviews, reference materials, and so on.

- Learning about the nature and requirements of the trade—tasks, working conditions, evaluation criteria and rights and responsibilities of workers—through visits, interviews, reference materials, and so on.

- Presenting the information gathered at a group meeting and discussing their views on the trade, i.e. advantages, disadvantages, requirements.

FIRST-LEVEL OPERATIONAL OBJECTIVE
SITUATIONAL OBJECTIVE

LEARNING CONTEXT

PHASE 2: **Information on and Participation in the Training Process**

- Discussing the skills, aptitudes, habits and knowledge required to practise the trade.

- Becoming familiar with the training process, i.e. program of study, training process, evaluation methods, certification of studies.

- Discussing how the training program prepares them for work as toolmakers.

- Sharing their initial reactions to the trade and the training process.

PHASE 3: **Evaluation and Confirmation of Career Choice**

- Preparing a report in which they:
  - specify their preferences, aptitudes and interests with respect to toolmaking;
  - assess their career choice by comparing the nature and requirements of the trade with their preferences, aptitudes and interests.

INSTRUCTIONAL GUIDELINES

The teacher should:

- Create a climate that favours the students' personal growth and integration into the job market.
- Encourage the students to engage in discussions and express their opinions.
- Motivate the students to take part in the suggested activities.
- Help the students to arrive at an accurate perception of the trade.
- Provide the students with the means to assess their career choice honestly and objectively.
- Make available all pertinent reference materials, e.g. information on the trade, training programs, guides.
- Organize a meeting with specialists in the field.
- Organize visits to companies that are representative of the workplace in toolmaking.

FIRST-LEVEL OPERATIONAL OBJECTIVE

SITUATIONAL OBJECTIVE

PARTICIPATION CRITERIA

PHASE 1:

- Gather information on most of the topics to be covered.
- Adequately express their views on the trade during a group discussion, relating them to the information they have gathered.

PHASE 2:

- Give their opinions on some requirements for practising the trade.
- Study the documents provided.
- Listen attentively to explanations.
- Adequately express their views on the training program during a group meeting.
- Clearly express their opinions.

PHASE 3:

- Write a report that:
  - sums up their preferences, interest and aptitudes with respect to the trade;
  - clearly explains how they arrived at their career choice.

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before undertaking any of the activities:

1. Be receptive to information about the trade and the training process.
2. Be willing to share their views on the trade with their classmates.

Before undertaking the activities of Phase 1:

3. Find information.
4. Determine how to record and present information.
5. Explain the term *entry-level qualifications*.
6. Explain the main rules governing group discussion.

Before undertaking the activities of Phase 2:

7. Differentiate between the skills and the aptitudes and knowledge required to practise a trade.
8. Describe the nature, purpose and content of a program of study.

Before undertaking the activities of Phase 3:

9. Differentiate between preferences, and aptitudes and interests.
10. Describe the main parts of a report confirming their career choice.

MODULE 2: MATHEMATICS APPLIED TO TOOL AND DIE MAKING

CODE: 866 312 **Duration: 30 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
apply concepts of mathematics to the manufacture of production machinery
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given
  - drawings of parts of complex shapes to be machined or inspected
  - the necessary technical documentation
- Using a calculator
- Following the teacher's instructions

GENERAL PERFORMANCE CRITERIA

- Mastery of imperial and metric measurement systems
- Accurate calculations
- Proper use of formulas and work methods
- Clean work

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
A. Interpret the drawing.	- Accurate interpretation of symbols - Complete list of dimensions and tolerances
B. Solve algebraic equations for the creation and rearrangement of formulas related to the manufacture of production machinery.	- Proper use of method of creating formulas - Proper use of method of rearranging formulas
C. Solve dimension string problems.	- Accurate calculation of: • the missing dimension • the minimum and maximum dimensions • the perimeter of the part • the volume of the part • the centre of gravity
D. Solve complex angle problems on jig parts or dies.	- Proper construction of triangles in accordance with the geometrical problems to be solved - Proper use of trigonometric formulas related to triangles

FIELD OF ACTIVITY

Tool and die making

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to interpret the drawing (A):

1. Learn about the targeted competency and the proposed learning process.
2. Translate the information contained in a drawing.

Before learning how to solve algebraic equations for the creation and rearrangement of formulas related to the manufacture of production machinery (B):

3. Solve basic algebraic equations.
4. Solve algebraic equations of the first degree.

Before learning how to solve dimension string problems (C):

5. Solve basic geometrical problems.
6. Calculate the minimum and maximum dimensions and the tolerance ranges.

Before learning how to solve complex angle problems on jig parts or dies (D):

7. Solve basic trigonometric problems.
8. Solve simple trigonometric problems.
9. Solve basic trigonometric problems related to triangles.
10. Show concern for accurate calculations.
11. Show concern for neatness.

MODULE 3: JIG BORING AND JIG GRINDING

CODE: 866 323 **Duration: 45 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
use jig boring and jig grinding techniques
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - a drawing
  - a milled and ground mild steel part
  - all the relevant technical documentation
- Using:
  - a jig borer or very good quality conventional vertical milling machine
  - the accessories necessary for mounting and clamping the workpiece
  - precision moving and positioning equipment
  - an internal grinder
  - the appropriate measuring instruments

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

GENERAL PERFORMANCE CRITERIA

- Conformity with occupational health and safety standards
- Mastery of techniques for using a jig borer or vertical milling machine
- Mastery of jig boring and jig grinding techniques
- Mastery of techniques for using measuring instruments and devices
- Quality of product:
  - conformity of machined part with drawing
  - observance of tolerances (imperial and metric systems):
    - diameter
    - position
    - centre to centre
    - parallelism
    - condition of surface
      - boring
      - grinding
- Observance of time limit

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
A. Interpret the drawing.	- Accurate interpretation of symbols - Complete list of dimensions and tolerances - Accurate interpretation of specific information
B. Lay out the work.	- Accurate layout - Conformity with drawing - Accurate calculation of rectangular coordinates - Accurate calculation of polar coordinates

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
C. Mount and position the workpiece.	- Appropriate selection of mounting accessories according to the type of machining to be done - Accurate positioning of workpiece on machine table - Proper clamping of piece - Accurate location of point of origin - Conformity with isostatic principles
D. Mount the tools and adjust the machine.	- Appropriate selection of tools or grinding wheel according to the type of machining to be done - Proper mounting of tools or grinding wheel - Accurate adjustment of revolution and feed according to the tool or grinding wheel used - Proper dressing of grinding wheel
E. Drill, bore and grind holes according to the dimensions and tolerances specified in the drawing.	- Effective work methods - Safe use of machine tool - Proper use of coolants - Conformity of dimensions with drawing
F. Inspect the finished part.	- Proper cleaning and deburring of the part - Complete verification of dimensions and surfaces of the part
G. Tidy up the work station.	- Cleanliness of machine tool and work area - Conformity with manufacturer's standards with respect to the lubrication of the machine - Proper storage of tools, accessories and measuring instruments

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

FIELD OF APPLICATION

Tool and die making

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to interpret the drawing (A):

1. Learn about the targeted competency and the proposed learning process.

Before learning how to lay out the work (B):

2. Clean a workpiece before laying out the work.
3. Determine the appropriate dye for a given job.
4. Distinguish between conventional dimensioning and coordinate dimensioning.
5. Recognize rectangular and polar coordinates in a drawing.
6. Describe the toolmaker's button method.

Before learning how to mount and position the workpiece (C):

7. Recognize the mounting accessories.
8. Identify the methods of positioning a workpiece on the table.
9. Identify the methods of locating a point of origin.

Before learning how to mount the tools and adjust the machine (D):

10. Recognize jig boring and jig grinding tools with respect to the operations to be performed.
11. Ensure the cutting quality of the jig boring tools.
12. Calculate the rotary speed of the tools.
13. Calculate the feed speed of the tools.
14. Distinguish among the different types of grinding wheels used on a jig grinder.
15. Recognize the safety devices on the machine.

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to drill, bore and grind holes according to the dimensions and tolerances specified in the drawing (E):

16. Identify the methods of controlling movements.
17. Be familiar with the safety rules related to the use of the machine.

Before learning how to inspect the finished part (F):

18. Select the measuring instruments and the testing devices.

MODULE 4: METALLURGY APPLIED TO PRODUCTION MACHINERY

CODE: 866 332 **Duration: 30 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
apply concepts of metallurgy to the manufacture of production machinery
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - a drawing of a production tool
  - pieces of steel to be treated
  - course notes
  - steel manufacturers' documentation
  - non-destructive testing devices

GENERAL PERFORMANCE CRITERIA

- Proper selection of steels and treatments
- Concern for precision

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
A. Interpret a drawing of a production tool.	- Accurate identification of the function of the tool - Accurate list of dimensions

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
B. Determine the physical and mechanical properties of the materials to be used.	- Method of determining the different physical and mechanical properties of non-ferrous metals and alloy steels according to the tool to be manufactured
C. Select the steels to be used.	- Accurate interpretation of manufacturers' charts
D. Determine the characteristics of the heat treatment.	- Appropriate choice of heat treatment - Appropriate choice of method of heating metals - Heating temperature accurate to ±25°F - Heating time accurate to ±5 min, at a constant temperature - Appropriate choice of steel tempering method - Tempering temperature accurate to ±25°F - Tempering time appropriate to the desired hardness
E. Determine the heat treatments required to confer certain mechanical properties on materials used to manufacture production machinery.	- Heat treatments for: • quenching • tempering • annealing • normalizing • spheroidizing • carburizing • carbonitriding • nitriding

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
F. Perform destructive testing on a piece of steel: • hardness • cracks • distortion	- Appropriate choice of hardness tester - Appropriate choice of liquid penetrant - Appropriate choice of measurement scale - Accurate performance of liquid penetrant test - Detection of physical deformations of the metal - Accurate explanation of quenching defects, such as: • insufficient hardness • fractures • burns • deformation
G. Apply health and safety rules.	- Observance of health and safety rules

FIELD OF APPLICATION

Tool and die making

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to interpret a drawing of a production tool (A):

1. Learn about the targeted competency and the proposed learning process.

Before learning how to determine the physical and mechanical properties of the materials to be used (B):

2. Identify the different ferrous and nonferrous metals used in production machinery.
3. Indicate the properties of the different metals used for alloys.

Before learning how to determine the characteristics of the heat treatment (D):

4. Describe the function, adjustment and use of heating devices.
5. Describe the function, adjustment and use of quenching baths.
6. Describe the function, adjustment and use of tempering ovens.
7. Indicate the safety measures to be taken when handling workpieces and using accessories and furnaces.

Before learning how to determine the heat treatments required to confer certain mechanical properties on materials used to manufacture production machinery (E):

8. Select the metals and ferrous and nonferrous alloys for industrial applications.
9. Identify the different carbon steels.

Before learning how to perform destructive testing on a piece of steel:

- **hardness**
- **cracks**
- **distortion (F):**

10. Describe the method of preparing surfaces to be tested.

MODULE 5: METROLOGY APPLIED TO JIGS

CODE: 866 492 **Duration: 30 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
apply concepts of metrology to the production of jigs
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - a jig with some quenched and milled components, linear dimensions, angular and circular shapes, different surfaces and different degrees of hardness
  - drawings indicating the dimensions and dimensional tolerances for shapes and positions as well as the surfaces and degrees of hardness
  - a precision surface plate
  - all the necessary documentation
- Using assembly tools and devices and instruments for inspecting the dimensions, shapes and positions of the elements

GENERAL PERFORMANCE CRITERIA

- Observance of occupational health and safety rules
- Mastery of techniques for using the different measuring and testing instruments and devices
- Cleanliness of work area and parts to be tested
- Concern for precision

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
A. Interpret the drawings.	- Accurate interpretation of symbols - Complete list of dimensions, shapes, surfaces and degrees of hardness - Accurate interpretation of dimensional and geometrical tolerances - Accurate list of reference points and surfaces - Proper use of the two measuring systems
B. Select the measuring and testing instruments and devices.	- Proper selection given the precision required and the shape, weight and volume of the jig
C. Inspect the dimensions and relative positions of the elements of a jig.	- Accurate calibration and adjustment of comparators - Proper use of comparators and gauges - Accurate reading of dimensions, i.e. 10% of determined tolerance ranges
D. Inspect the surface of the parts.	- Accurate calibration and adjustment of roughness tester - Proper use of roughness tester - Identification of condition of surfaces, i.e. ±2 micro inches (0.05 micron)
E. Test the hardness of the case hardened parts.	- Accurate calibration and adjustment of hardness tester - Proper use of hardness tester - Identification of hardness, i.e. ±1 Rockwell

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
F. Detect quenching defects in the quenched parts of the jig.	- Complete list of quenching defects: • breaks • fractures • cracks • burns • deformations
G. Write the different measurements on the quality control sheet.	- Accurate indication of: • dimensions of the parts • condition of the surfaces • degrees of hardness - Legibility - Relevance of comments
H. Maintain and put away the measuring instruments and testing devices.	- Maintenance and storage in conformity with manufacturer's standards

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to interpret the drawings (A):

1. Learn about the targeted competency and the proposed learning process.
2. Apply basic knowledge about drawing.

Before learning how to select the measuring and testing instruments and devices (B):

3. Identify the different measuring and testing instruments and devices.

Before learning how to inspect the dimensions and relative positions of the elements of a jig (C):

4. Recognize the geometrical elements of the jigs.
5. Show concern for the careful handling of measuring instruments and assembly tools on a surface plate.
6. Show concern for the effects of temperature on the precision of the instruments.
7. Adopt a safe work attitude.

Before learning how to inspect the surface of the parts (D):

8. Describe the characteristics and method of using and maintaining comparator specimens.
9. Recognize surface defects and irregularities by sight.

Before learning how to test the hardness of the case hardened parts (E):

10. Describe the characteristics of the different hardness testers.

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to detect quenching defects in quenched parts of the jig (F):

11. Describe the components of Magnaflux and Magnaglo heat treatment defect testers.

Before learning how to write the different measurements on the quality control sheet (G):

12. Demonstrate the importance of quality control.

MODULE 6: TECHNIQUES FOR ASSEMBLING JIGS

CODE: 866 503 **Duration: 45 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
apply techniques for assembling jigs
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - premachined elements
  - an assembly drawing for a jig with several assemblies and subassemblies
- Using:
  - the necessary tools and assembly elements
  - the necessary measuring instruments
  - a good quality drill or vertical milling machine to drill the holes
  - a press or an oven and dry ice to assemble tight-fitting parts
  - an electric or gas welding unit for permanent assemblies

GENERAL PERFORMANCE CRITERIA

- Observance of occupational health and safety rules
- Observance of sequence of steps involved in assembling the jig
- Quality product:
  - accurate alignment of guides
  - accurate positioning of supports for the workpiece
  - observance of required tolerances
  - solid assembly
- Cleanliness of work area and workpieces

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
A. Determine the methods to be used in assembling a jig.	– Proper selection of assembly methods to: • facilitate the work • obtain a solid, precise assembly • facilitate the mounting and removal of workpieces
B. Select the fasteners.	- Proper selection of fasteners according to: • the assembly methods • the composition of the workpieces to be assembled
C. Select the necessary tools.	- Proper selection of transfer and cutting tools in accordance with the work to be done
D. Assemble the parts.	- Observance of techniques for transferring stud and screw hole locations - Observance of technique for tight-fitting assembly - Accurate alignment of guides, stops and alignment pins
E. Check the diameters of the bored holes and the alignment of the parts.	- Proper selection of instruments - Proper use of instruments - Accurate indication of any difference in the allowances - Accurate indication of the alignment of the parts

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to determine the methods to be used in assembling a jig (A):

1. Learn about the targeted competency and the proposed learning process.
2. Interpret the standardized indications on the drawings for a jig.
3. Recognize the different assembly methods.

Before learning how to select the fasteners (B):

4. Recognize the different fasteners.

Before learning how to select the necessary tools (C):

5. Recognize the different cutting tools.
6. Inspect the cutting tools.

Before learning how to assemble the parts (D):

7. Explain the operation of the machinery and machine tools necessary for assembly.

Before learning how to check the diameters of the bored holes and the alignment of the parts (E):

8. Identify the different measuring instruments.

MODULE 7: FUNCTIONAL STUDY OF A MACHINE TOOL

CODE: 866 512 **Duration: 30 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
do a functional study of a machine tool
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - the manufacturer's manual
  - all the appropriate documentation
- Using the following machine tools:
  - lathe, milling machine, jig borer, conventional or numerically controlled grinder

GENERAL PERFORMANCE CRITERIA

- Conformity with occupational health and safety standards
- Complete and proper inspection of components and mechanisms of the machine tool
- Accurate and complete evaluation of the operation of the machine tool

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
A. Inspect the kinematic chain of a machine tool.	- Complete inspection of linear and rotary motion of the machine tool - Accurate description of the movement of the workpiece and the tool to produce a surface
B. Evaluate the capacity and power of a machine tool.	- Accurate evaluation of the maximum volume of workpiece that a machine tool can accommodate - Accurate evaluation of limited cutting forces
C. Check the range of rotational speeds and feed rates of a machine tool.	- Accurate list of rotational speeds and feed rates
D. Study the different mechanisms related to the general operation of a machine tool.	- Accurate description of mechanisms and correct indication of mechanical principles: • table guides • spindle bearings • motion limiters • motion controls • methods of greasing the various parts

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
E. Evaluate the degree of precision of a machine tool.	- Accurate evaluation of degree of precision: • movement of tables • spindle rotation - Accurate evaluation of degree of rigidity of: • the casing • the mechanisms for the transmission of movement • the locking mechanisms - Accurate evaluation of degree of wear of the machine tool
F. Run a machine tool without load.	- Proper inspection of machine tool: • feed • spindle rotations • motion limits • mechanisms for stopping the spindle

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to inspect the kinematic chain of a machine tool (A):

1. Learn about the targeted competency and the proposed learning process.
2. Define the term *kinematic chain*.

Before learning how to evaluate the capacity and power of a machine tool (B):

3. Calculate the feed rates and cutting speeds of the metals to be machined given the peripheral speeds suggested by the manufacturers.
4. Select the appropriate component for a given cutting tool.

Before learning how to check the range of rotational speeds and feed rates of a machine tool (C):

5. Describe the mechanisms for adjusting the rotational speed on different machine tools.

Before learning how to study the different mechanisms related to the general operation of a machine tool (D):

6. Recognize different motion limiters.
7. Recognize different spindle bearings.

Before learning how to evaluate the degree of precision of a machine tool (E):

8. Use measuring instruments to test the precision of a machine tool.
9. Indicate the factors related to the rigidity of a machine tool.
10. Indicate the factors related to the wear of a machine tool.

MODULE 8: MAKING A DRILL JIG

CODE: 866 525 **Duration: 75 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
manufacture, assemble and adjust a drill jig
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - the drawing for a drill jig provided by the teacher
  - a planning sheet previously produced by the student
  - manufacturers' catalogues of components for drilling and fastening workpieces
  - the necessary documentation
- Using:
  - the necessary machine tools, accessories and measuring instruments
  - a boring tool mounted on a vertical milling machine or on a jig borer, preferably numerically controlled (three axes)

GENERAL PERFORMANCE CRITERIA

- Conformity with occupational health and safety standards
- Proper use of measuring instruments to check the tolerances of shapes and positions of bored holes
- Result:
  - parts produced with the drill jig in conformity with the drawing
  - cleanliness of jig
- Accurate calculations

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
A. Interpret the drawing for a drill jig.	- Recognition of the function of the jig - Accurate interpretation of standardized notes and symbols - Recognition of surfaces and shapes to be used - Accurate interpretation of allowances, tolerances and adjustments - Recognition of all devices for positioning and holding the workpiece in the jig - Gathering of information necessary to make the jig: • parts to be manufactured • parts to be bought • transfer of dimensions • tolerances of shapes and positions - Proper selection of steels

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
B. Produce a planning sheet.	- Complete planning sheet for each part of the jig, according to: • the routines, subroutines and operations • the types of machines selected for each routine • the tools, equipment and testing instruments for each operation • the sketches dimensioned in machining position for each subroutine • the appropriate symbols for the elimination of degrees of freedom in conformity with isostatic principles • the specifications for the assembly and machining of the subassemblies and the entire jig, for each of the parts to be machined - Proper selection of cutting tools
C. Premachine the parts of the jig.	- Observance of techniques for using machining accessories - Parts oversized in accordance with their shape and dimensions
D. Apply heat treatments.	- Proper choice of temperature and duration of: • quenching • tempering - Hardness accurate to ± 2 HRC - Proper use of hardness tester

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
E. Do the final machining and inspection of the parts.	- Observance of techniques for using a universal boring head - Observance of techniques for using grinders - Observance of lapping and polishing techniques - Observance of tolerances: • shapes • positions • surfaces • allowances - Cleanliness of parts - Complete inspection of purchased parts
F. Plan the assembly.	- Complete planning of the following elements of the assembly and subassemblies: • routines, subroutines and operations • the necessary tools for each operation • sketches dimensioned in assembly position for each of the subroutines • observance of symbols for adjustments and allowances
G. Assemble the drill jig.	- Observance of procedure for making assemblies and subassemblies - Observance of tolerances of shapes, positions and allowances - Solid assembly
H. Use the drill jig.	- Proper operation of jig for production of first part

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to interpret the drawing for a drill jig (A):

1. Learn about the targeted competency and the proposed learning process.
2. Recognize the different categories of drill jigs.
3. Distinguish the parts to be made from those that can be purchased.
4. Recognize the assembly adjustments.

Before learning how to produce a planning sheet (B):

5. Select the symbols for isostatic location.
6. Select the methods for machining the part to be made.
7. Select the machine tools, boring accessories and cutting tools.
8. Select the measuring instruments.

Before learning how to apply heat treatments (D):

9. Indicate the changes to the physical and mechanical properties of steels resulting from the different heat treatments.
10. Recognize the different instruments for testing the hardness of metals.
11. Describe the method of preparing surfaces to be tested after quenching.

Before learning how to do the final machining and inspection of the parts (E):

12. Identify the surfaces to be machined and the quantity of material to be removed with respect to a point of reference on the workpiece.
13. Select the measuring instruments and testing devices.

Before learning how to plan the assembly (F):

14. Select the type of press required for the assembly.
15. Describe the different methods of aligning parts.
16. Select methods for transferring hole locations.

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to use the drill jig (H):

17. Identify the methods of mounting and fastening the jig to the machine tool.
18. Describe the methods of aligning and positioning the jig on the machine tool.

MODULE 9: COMMUNICATION IN THE WORKPLACE

CODE: 866 421 **Duration: 15 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
SITUATIONAL OBJECTIVE

EXPECTED OUTCOME

By participating in the required activities of the learning context according to the indicated criteria, the students will be able to
communicate in the workplace.

SPECIFICATIONS

At the end of this module, the students will:

- Be familiar with the different aspects of communication in the workplace.
- Apply techniques related to oral and written communication in the workplace.
- Be familiar with their strengths and weaknesses with respect to communication.

LEARNING CONTEXT

PHASE 1: **Familiarity with the General Principles of Communication in the Workplace**

- Participating in an activity that will help them become aware of the importance of communication in the workplace.

- Discussing the differences, in terms of communication, between personal and professional relationships.

- Learning about the different elements of the communication process.

- Learning, during a simulation, about the different levels of communication.

FIRST-LEVEL OPERATIONAL OBJECTIVE
SITUATIONAL OBJECTIVE

LEARNING CONTEXT

- Discussing the basic elements of good communication.

- Discussing, using examples, the use of different means of communication in the workplace.

PHASE 2: **Familiarity with the Different Aspects of Communication in the Workplace**

- Participating in learning situations that will help them recognize the main difficulties related to communication in the workplace.

- Discussing, on the basis of observations made during the learning situations, the different factors underlying the difficulties identified.

- Learning the rules of effective communication in the workplace.

PHASE 3: **Use of the Different Techniques Related to Oral and Written Communication in the Workplace**

- Participating in group activities that will allow them to practise different oral communication techniques.

- Participating in activities that will allow them to practise written communication techniques.

PHASE 4: **Evaluation of Their Ability to Communicate**

- Analyzing, in teams, situations in which their strengths and weaknesses with respect to communication were revealed.

- Discussing, as a group, means of improving their communication skills.

FIRST-LEVEL OPERATIONAL OBJECTIVE
SITUATIONAL OBJECTIVE

INSTRUCTIONAL GUIDELINES

The teacher should:

- Create a climate of trust and openness.
- Facilitate communication by using leadership techniques.
- Encourage students to take risks and commit themselves.
- Develop learning situations related to the workplace.
- Carefully prepare structured activities taking into account objectives, materials, instructions, durations and evaluation grids.

PARTICIPATION CRITERIA

PHASE 1:

- Participate actively in the activities.
- Show an interest in the topics discussed during the activities.

PHASE 2:

- Attempt to contribute positively to the learning situations aimed at highlighting the main difficulties related to communication in the workplace.
- Participate actively in the discussions and contribute relevant points.
- Attempt to illustrate the rules of communication necessary for effective relationships in the workplace.

PHASE 3:

- Show an interest and attempt to correctly apply oral and written communication techniques.

PHASE 4:

- Report seriously on their strengths and weaknesses with respect to communication.
- Attempt to find ways of improving their communication skills.

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before undertaking the activities of Phase 1:

1. Learn about the targeted competency and the proposed learning process.
2. Be receptive to information related to communication in the workplace.
3. Participate and share their perceptions with their classmates.
4. Define the term *communication*.

Before undertaking the activities of Phase 4:

5. Describe the characteristics of effective feedback.

MODULE 10: ANALYZING A JIG DRAWING

CODE: 866 532 **Duration: 30 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
analyze the construction of a production jig in a drawing
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - the drawing for the part to be machined
  - a general drawing of a production jig
  - drawings of the components of the jig
  - manufacturers' recommendations
  - information about the jig's design:
    - number of parts to be machined
    - degree of precision required
    - finish quality desired
    - allowances, tolerances, etc.
  - all the appropriate documentation
- Using a calculator

GENERAL PERFORMANCE CRITERIA

- Accurate and complete list of errors in the drawing and improvements that could be made
- Relevance of changes suggested
- Clear, accurate explanations

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
A. Interpret the drawing of the part to be machined.	- Identification of all the information necessary for making the part: • shapes • angles and radii • composition of the material used • hardness • dimensions • tolerances
B. Find the general information on the drawing of the production jig.	- Recognition of the production jig and the machine on which it will be used - Recognition of the different components of the jig
C. Evaluate the positioning and assembly of the components of the jig.	- Relevant judgment of: • the size of the jig • the positions of the guides • the positions of the clamping systems • the fasteners and assembly methods • the means of fastening the jig to the machine • the means of fastening the workpiece to the jig - Correct judgment of result obtained with respect to the material used, as well as the thickness and hardness of the part to be made - Correct judgment of the positioning and dimensions of the points of assembly taking into account the manufacturer's recommendations
D. Evaluate the devices that position and hold the workpiece in the jig.	- Correct judgment of the relevance of the devices in the drawing, taking into account the rules of isostatics

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
E. Evaluate the operating procedure of the jig.	- Correct judgment of the relevance of the operating procedure of the jig - Accurate, coherent explanations of their reasoning
F. Evaluate the selection of the suggested steels.	- Correct judgment of: • the types of steel • the hardness of the steels
G. Evaluate the quality of the finish of the parts of the jig.	- Correct judgment taking into account: • the number of parts to be produced • the dimensions and tolerances required

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to interpret the drawing of the part to be machined (A):

1. Learn about the targeted competency and the proposed learning process.
2. Apply basic knowledge about drawing.

Before learning how to find the general information on the drawing of the production jig (B):

3. Recognize the different types of production jigs.

Before learning how to evaluate the positioning and assembly of the components of the jig (C):

4. Define the factors that determine the design of the production jig.
5. Recognize the different pins and screws.
6. Apply standards related to the dimensions of the positioning and fastening holes.

Before learning how to evaluate the devices that position and hold the workpiece in the jig (D):

7. Define isostatics.
8. Use the technical documentation on the devices for positioning and holding the workpiece.

Before learning how to evaluate the operating procedure of the jig (E):

9. Indicate the factors governing the study of machining assemblies.
10. Recognize the different assembly elements used on jigs.
11. Recognize the devices for positioning the workpieces in the jigs.

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to evaluate the selection of the suggested steels (F):

12. Differentiate between carbon steels and tool steels.
13. Determine the heat treatments according to the expected results.

Before learning how to evaluate the quality of the finish of the parts of the jig (G):

14. Interpret the tables of finishing standards for parts in accordance with how they are machined and their role in the jig.

MODULE 11: MAKING A LATHE JIG

CODE: 866 546 **Duration: 90 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
manufacture, assemble and adjust a lathe jig
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - the drawing of a simple part to be machined on a lathe
  - the sketch of a lathe jig designed by the student
  - a planning sheet produced previously by the student
  - the necessary documentation
  - manufacturer's catalogues of components for positioning and holding workpieces
- Using:
  - an engine lathe equipped with a universal chuck or a boring tool mounted on a vertical milling machine or on a three-axis numerically controlled jig borer
  - the necessary machine tools, tools and measuring instruments

GENERAL PERFORMANCE CRITERIA

- Conformity with occupational health and safety standards
- Mastery of manufacturing and assembly process for the different components of the lathe jig
- Mastery of techniques for assembling the jig on an engine, turret or CNC lathe
- Proper use of measuring instruments used to check tolerances of boring shapes and positions
- Quality product: conformity of part with drawing

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
A. Interpret the drawing of the part to be machined.	- Identification of all the information necessary for making the part: • shapes • angles and radii • materials used • dimensions • tolerances • oversize • reference point
B. Design a lathe jig.	- Proper choice of shape and size of jig - Accurate determination of the position of the workpiece in the jig - Proper choice of positioning points and holding system - Proper choice of type of lathe - Proper choice of steels for the jig - Proper choice of system for fastening the jig to the lathe
C. Make the sketches.	- Observance of the steps involved in designing a jig - Clear sketch of the jig - Observance of drawing conventions: • dimensions • cut-away views • symbols • manufacturing notes, allowances and tolerances - Clear sketch of each part of the whole to be made - Accurate calculation of dimensions - Proper positioning of dimensions on the sketches

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
D. Produce the planning sheet.	- Complete planning sheet for each part of the jig, according to: • the routines, subroutines and operations • the types of machines selected for each routine • the tools and testing instruments for each operation • the choice of heat treatments • the sketches dimensioned in machining position for each subroutine • the appropriate symbols for the elimination of degrees of freedom in conformity with isostatic principles • the specifications for the assembly of the subassemblies and the entire jig, for each of the parts to be machined
E. Premachine the parts of the jig.	- Observance of techniques for using machining accessories - Parts oversized in accordance with their shape and dimensions
F. Apply heat treatments.	- Proper choice of temperature and duration of: • quenching • tempering - Hardness accurate to ±2 HRC - Proper use of hardness tester

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
G. Do the final machining and inspection of the parts.	- Observance of techniques for using grinders - Observance of techniques for using precision machining accessories - Observance of lapping and polishing techniques - Observance of tolerances: • shapes • positions • surfaces • allowances - Cleanliness of parts - Complete inspection of purchased parts
H. Plan the assembly.	- Complete planning of the following elements of the assembly and subassemblies: • routines, subroutines and operations • the necessary tools for each operation • sketches dimensioned in assembly position for each of the subroutines • observance of symbols for adjustments and allowances
I. Assemble the lathe jig.	- Observance of procedure for making assemblies and subassemblies - Observance of tolerances specified in the drawing - Solid assembly

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
J. Make the final adjustments to the lathe jig.	- Accurate mounting of jig on the machine tool - Accurate balancing of jig (static or dynamic) - Complete inspection of the operation of the jig: • alignment for: - longitudinal movement - transverse movement • positioning and fastening of workpiece - Solidity of jig - Ease of mounting and adjustment of jig on lathe

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to interpret the drawing of the part to be machined (A):

1. Learn about the targeted competency and the proposed learning process.
2. Apply basic knowledge about drawing.

Before learning how to design a lathe jig (B):

3. Define the factors that determine the design of a lathe jig.
4. Define isostatics.
5. Use catalogues of jig accessories.
6. Recognize the different procedures for making jigs.
7. Distinguish the parts to be made from those that can be purchased.

Before learning how to produce the planning sheet (D):

8. Select the symbols for isostatic location.
9. Analyze the feasibility of the assembly.
10. Select the methods of machining parts.
11. Select the machine tools, boring accessories and cutting tools.

Before learning how to apply heat treatments (F):

12. Indicate the changes to the physical and mechanical properties of steel that result from the different heat treatments.
13. Recognize the different hardness testers.
14. Describe the method for preparing surfaces to be tested after quenching.

Before learning how to do the final machining and inspection of the parts (G):

15. Identify the surfaces to be machined and the quantity of material to be removed with respect to a reference point on the workpiece.

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to plan the assembly (H):

16. Describe the different methods for aligning parts.
17. Select the methods for transferring hole locations.
18. Describe the different methods of assembling parts.
19. Inspect the parts to be assembled.

MODULE 12: MACHINING MATERIALS WITH LOW MACHINABILITY RATINGS

CODE: 866 371 **Duration: 15 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
apply knowledge related to the machining of materials with low machinability ratings
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - drawings of mechanical parts to be machined, made of high alloy materials
  - various catalogues of cutting tools provided by the teacher
  - the necessary technical documentation
- Using:
  - real tools or graphic representations of tools
  - real machine tools or graphic representations of machine tools

GENERAL PERFORMANCE CRITERIA

- Selection of cutting tools, rotational speeds and feed rates promoting maximum performance of the machine tool

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
A. Determine the factors inherent in the performance and quality of a cut.	- Determination of the main factors that influence performance and quality: • materials used • cutting tool materials • lubrication • types of machining and assembly • fixation of tool • power and rigidity of machine
B. Demonstrate the optimal operating conditions for the tools.	- Clear justification of economical and optimal cutting conditions taking into account: • the selection of tools • the use of charts • cutting problems • cutting parameters • mounting and fastening of tools

FIELD OF APPLICATION

Tool and die making

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to determine the factors inherent in the performance and quality of a cut (A):

1. Learn about the targeted competency and the proposed learning process.
2. Distinguish between materials with low machinability ratings and materials with high machinability ratings.
3. Associate cutting tools with different operations or with the machining of different shapes.
4. Distinguish between high-speed steel tools on the one hand, and carbide, ceramic and diamond-tipped tools on the other.
5. Summarize the characteristics of the materials used for making tips.
6. Explain the effects of cutting fluids.
7. Demonstrate the importance of the mounting of the workpiece.
8. Detect cutting problems specific to different machine tools.
9. Show concern for performance when selecting and using tools.

Before learning how to demonstrate the optimal operating conditions for the tools (B):

10. Identify the tools and toolholders used on the different machine tools.
11. Summarize the action of cutting tools.
12. Demonstrate the importance of correctly installing the tools.
13. Use charts.
14. Recognize cutting problems by sight.

MODULE 13: SPARK EROSION MACHINING

CODE: 866 392 **Duration: 30 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
do a spark erosion machining operation
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Working alone
- Given:
  - a drawing of a tool part
  - the necessary technical documentation
- Using:
  - a wire or electrode electrical discharge machine
  - mounting accessories

GENERAL PERFORMANCE CRITERIA

- Observance of occupational health and safety rules
- Mastery of techniques for using spark erosion machining procedures
- Conformity of machined part with drawing
- Clean work

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
A. Interpret the drawing of a part to be machined.	- Accurate interpretation of: • symbols • instructions
B. Determine the need to use a spark erosion machining process.	- Relevant choice of operation and process according to: • the complexity of the shape • the dimensional and surface precision • the machining time
C. Plan the work.	- Proper selection of measuring instruments - Calculation of movements and missing dimensions - Determination of sequence of operations - Determination of reference point of workpiece - Proper choice of flushing system
D. Mount the workpiece on the machine.	- Proper choice of mounting accessories and type of assembly - Accurate positioning of fasteners - Solid assembly
E. Prepare and mount the electrode.	- Proper choice of material of electrode according to: • the type of part to be produced • the quality of part to be produced - Proper choice of means of fastening the electrode to the machine head - Accurate positioning of electrode in electrode holder

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
F. Prepare the machine and attach the wire.	- Proper choice of size and material of wire - Determination of feed on X and Y axes - Machine programming in conformity with drawing
G. Machine the workpiece.	- Observance of technique - Dimensions and shapes in conformity with drawing - Accurate positioning of electrode or wire in accordance with the job to be done
H. Deburr and clean the workpiece.	- No burrs - Clean workpiece
I. Control the quality of the work.	- Accurate measurements taken - Proper use of measuring instruments: • delicate handling • dexterity
J. Tidy up the work station.	- Complete cleanup of machine - Proper greasing and lubrication of machine

FIELD OF APPLICATION

Tool and die making

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to interpret the drawing of a part to be machined (A):

1. Learn about the targeted competency and the proposed learning process.
2. Do the necessary calculations.

Before learning how to determine the need to use a spark erosion machining process (B):

3. Explain the principle of alternating current.
4. Explain the principle of direct current.
5. Describe the role of a current rectifier.
6. Describe the role of a transformer.
7. Describe the role of dielectric fluid.
8. Explain the principle of electrical discharge machining.
9. Identify the main materials used in making electrodes.
10. Identify the different types of electrodes.

Before learning how to mount the workpiece on the machine (D):

11. Evaluate the condition of the tools and measuring instruments by sight.
12. Calibrate the measuring instruments.
13. Inspect the electrical discharge machine.
14. Indicate the functions of the different controls.

Before learning how to deburr and clean the workpiece (H):

15. Identify the methods of cleaning and deburring.

Before learning how to control the quality of the work (I):

16. Use direct and indirect measuring instruments.

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to tidy up the work station (J):

17. Learn about the importance of maintaining the work station.

MODULE 14: MAKING A MILLING JIG

CODE: 866 558 **Duration: 120 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
manufacture, assemble and adjust a milling jig
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - the drawing of a simple part to be milled using a jig
  - all the necessary documentation
- Using the necessary machine tools, accessories and measuring instruments

GENERAL PERFORMANCE CRITERIA

- Observance of occupational health and safety rules
- Mastery of techniques for adjusting and using machine tools
- Proper use of measuring instruments used to check tolerances of shapes and positions
- Design of a jig appropriate to the part to be machined
- Quality product: conformity of part with drawing

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
A. Interpret the drawing of the part to be machined.	- Identification of all the information necessary for making the part: • shapes • angles and radii • materials used • dimensions • tolerances • oversize • reference point
B. Design a milling jig.	- Proper choice of shape and size of jig - Accurate determination of the position of the workpiece in the jig - Proper choice of positioning points and holding system - Proper choice of type of milling machine - Proper choice of steels for the jig - Proper choice of system for holding the jig to the milling machine
C. Make the sketches.	- Observance of the steps involved in designing a jig - Clear sketch of the milling jig - Observance of conventions: • dimensions • cut-away views • symbols • manufacturing notes, allowances and tolerances - Clear sketch of each part to be made - Accurate calculation of dimensions - Proper positioning of dimensions on the sketches

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
D. Produce the planning sheet.	- Complete planning sheet for each piece of the jig, according to: • the routines, subroutines and operations • the types of machines selected for each routine • the tools and testing instruments for each operation • the choice of heat treatments • the sketches dimensioned in machining position for each subroutine • the appropriate symbols for the elimination of degrees of freedom in conformity with isostatic principles • the specifications for the assembly of the subassemblies and the entire jig, for each of the parts to be machined
E. Premachine the pieces of the jig.	- Proper use of precision machining accessories - Parts oversized in accordance with their shape and dimensions
F. Apply heat treatments.	- Proper choice of temperature and duration of: • quenching • tempering - Hardness accurate to ±2 HRC - Proper use of hardness tester

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
G. Do the final machining and inspection of the parts.	- Observance of techniques for using: • finishing machine tools • a universal boring head • an internal grinder - Observance of tolerances: • shapes • positions • surfaces • allowances - Cleanliness of parts - Proper maintenance of work station
H. Plan the assembly.	- Complete planning of the following elements of the assembly and subassemblies: • routines, subroutines and operations • the necessary tools for each operation • sketches dimensioned in assembly position for each of the subroutines • observance of symbols for adjustments and allowances
I. Assemble the milling jig.	- Observance of procedure for making assemblies and subassemblies - Observance of tolerances for shapes, positions and allowances - Precision of positioning of support points for the workpiece in the jig - Solid assembly

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
J. Make the final adjustments to the milling jig.	- Accurate mounting of jig on the machine tool - Complete inspection of the operation of the jig: • alignment for: - perpendicular movement - longitudinal movement - transverse movement • positioning and fastening of workpiece • solidity of jig • ease of mounting and adjustment of jig on milling machine

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to interpret the drawing of the part to be machined (A):

1. Learn about the targeted competency and the proposed learning process.
2. Apply basic knowledge about drawing.

Before learning how to design a milling jig (B):

3. Define the factors that determine the design of a milling jig.
4. Describe the forces that act on the jig during machining.
5. Recognize the different procedures for making jigs.
6. Use catalogues for guiding, holding and fastening accessories.
7. Distinguish the parts to be made from those that can be purchased.

Before learning how to produce the planning sheet (D):

8. Select the symbols for isostatic location.
9. Analyze the feasibility of the assembly.
10. Select the methods of machining parts.
11. Select the machine tools, accessories and cutting tools.

Before learning how to apply heat treatments (F):

12. Indicate the changes to the physical and mechanical properties of steel that result from the different heat treatments.
13. Recognize the different hardness testers.
14. Describe the method for preparing surfaces to be tested after quenching.

Before learning how to do the final machining and inspection of the parts (G):

15. Identify the surfaces to be machined and the quantity of material to be removed with respect to a reference point on the workpiece.

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to plan the assembly (H):

16. Describe the different methods of aligning parts.
17. Select the methods of transferring hole locations.
18. Describe the different methods of assembling parts.
19. Inspect the parts to be assembled.

MODULE 15: SURFACE GRINDING IRREGULAR SHAPES

CODE: 866 412 **Duration: 30 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
grind a workpiece with complex, irregular shapes on a surface grinder
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - a drawing of a part with complex, irregular shapes
  - a premachined and quenched workpiece with at least one concave shape and one convex shape with parallel and angular connections
  - the necessary documentation
- Using:
  - a surface grinder, preferably numerically controlled
  - the necessary dressing instruments
  - an optical comparator

GENERAL PERFORMANCE CRITERIA

- Conformity with occupational health and safety standards
- Mastery of techniques for using surface grinders and their accessories, as well as measuring and testing instruments and devices
- Quality of finished work:
  - conformity of part with drawing
  - observance of tolerances with respect to shapes, positions and surfaces (imperial and metric systems)
- Cleanliness of machined part, instruments and work area
- Observance of time limit

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
A. Interpret the drawing.	- Accurate interpretation of symbols for shapes and positions - Complete list of dimensions and tolerances for the shapes to be ground
B. Determine and calculate the tangential coordinates necessary for grinding the shapes of the part.	- Accurate determination of coordinates - Accurate calculations
C. Produce the planning sheet.	- Proper choice of surface grinder - Logical grinding sequence - Accurate indication of adjustment points on wheel dressers - Choice of grinding wheel appropriate to the characteristics of the part to be machined: • types of materials used • hardness • shape - Choice based on manufacturer's recommendations - Proper choice of tools and measuring and testing instruments - Clear, precise sketches
D. Inspect the workpiece before grinding.	- Accurate inspection of: • dimensions • distortion • hardness of the piece
E. Mount the grinding wheel.	- Observance of process for inspecting and balancing the grinding wheel

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
F. Prepare the tools and measuring instruments.	- Accurate calibration and adjustment of measuring and testing instruments, as well as the device for cutting complex profiles
G. Inspect and lubricate the grinder.	- Accurate evaluation of operating condition - Conformity with manufacturer's lubrication and maintenance standards
H. Dress the grinding wheel.	- Proper choice of diamond - Proper choice of method for cutting the grinding wheel - Observance of technique for dressing the profile of the grinding wheel
I. Install the fasteners.	- Proper selection of fasteners - Appropriate, safe installation technique
J. Adjust the grinder.	- Mastery of process of adjusting feed and depth of cut - Proper use of numerical controls
K. Do the work.	- Proper, safe mounting of workpiece - Conformity with planning sheet - Conformity of part with drawing - Safe use of machine tool - Proper use of coolants
L. Inspect the finished part.	- Proper cleaning and deburring of part - Complete verification of measurements of part

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
M. Tidy up the work station.	- Cleanliness of machine tool and work area - Conformity with manufacturer's lubrication standards - Proper disassembly and storage of tools, accessories and measuring instruments

FIELD OF APPLICATION

Tool and die making

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to interpret the drawing (A):

1. Learn about the targeted competency and the proposed learning process.
2. Apply basic knowledge about drawing.

Before learning how to determine and calculate the tangential coordinates necessary for grinding the shapes of the part (B):

3. Apply basic concepts of plane geometry.
4. Apply basic concepts of trigonometry.

Before learning how to produce the planning sheet (C):

5. Identify surface grinders.
6. Use manufacturers' tables related to grinding wheels.
7. Recognize the characteristics of a grinding wheel.
8. Identify the different types of wheel dressers for surface grinders.

MODULE 16: GRINDING IRREGULAR SHAPES ON A CYLINDRICAL GRINDER

CODE: 866 432 **Duration: 30 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
grind a workpiece with complex, irregular shapes on a **cylindrical grinder**
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - a drawing of a cylindrical part with complex, irregular shapes
  - a premachined and quenched workpiece with cylindrical or conical surfaces and at least one concave connection and one convex connection
  - the necessary documentation
- Using:
  - a cylindrical grinder, preferably numerically controlled
  - the necessary dressing instruments
  - an optical comparator

GENERAL PERFORMANCE CRITERIA

- Conformity with occupational health and safety standards
- Mastery of techniques for using cylindrical grinders and their accessories, as well as measuring and testing instruments and devices
- Quality of finished work:
  - conformity of part with drawing
  - observance of tolerances with respect to shapes, positions and surface (imperial and metric systems)
- Cleanliness of machined part, instruments and work area
- Observance of time limit

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
A. Interpret the drawing.	- Accurate interpretation of symbols for shapes and positions - Complete list of dimensions and tolerances for the shapes to be ground
B. Determine and calculate the tangential coordinates necessary for grinding the shapes of the part.	- Accurate determination of coordinates - Accurate calculations
C. Produce the planning sheet.	- Proper choice of cylindrical grinder - Logical grinding sequence - Accurate indication of adjustment points on wheel dressers - Choice of grinding wheel appropriate to the characteristics of the part to be machined: • types of materials used • hardness • shape - Choice based on manufacturer's recommendations - Proper choice of tools and measuring and testing instruments - Clear, precise sketches
D. Inspect the workpiece before grinding.	- Accurate inspection of: • dimensions • distortion • hardness of the piece
E. Mount the grinding wheel.	- Observance of process for inspecting and balancing the grinding wheel

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
F. Prepare the tools and measuring instruments.	- Accurate calibration and adjustment of measuring and testing instruments, as well as the device for cutting complex profiles
G. Inspect and lubricate the grinder.	- Accurate evaluation of operating condition - Conformity with manufacturer's lubrication and maintenance standards
H. Dress the grinding wheel.	- Proper choice of diamond - Proper choice of method for cutting the grinding wheel - Observance of technique for dressing the profile of the grinding wheel
I. Install the fasteners.	- Proper selection of fasteners - Appropriate, safe installation technique
J. Adjust the grinder.	- Mastery of process of adjusting feed and depth of cut - Proper use of numerical controls
K. Do the work.	- Proper, safe mounting of workpiece - Proper adjustment of table or grinding head - Conformity with planning sheet - Conformity of part with drawing - Safe use of machine tool - Proper use of coolants
L. Inspect the finished part.	- Proper cleaning and deburring of part - Complete verification of measurements of part

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
M. Tidy up the work station.	- Cleanliness of machine tool and work area - Conformity with manufacturer's lubrication standards - Proper disassembly and storage of tools, accessories and measuring instruments

FIELD OF APPLICATION

Tool and die making

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to interpret the drawing (A):

1. Learn about the targeted competency and the proposed learning process.

Before learning how to produce the planning sheet (C):

2. Distinguish between the characteristics of universal cylindrical grinders and those of plain cylindrical grinders.
3. Describe the main techniques for external and internal cylindrical/conical grinding.

Before learning how to dress the grinding wheel (H):

4. Name the factors that determine the need to dress a grinding wheel.

MODULE 17: MAKING GAUGES

CODE: 866 564 **Duration: 60 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
manufacture, assemble and adjust gauges
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - the drawing of a simple part to be inspected with two go, no-go gauges (cylindrical plug gauge and adjustable snap gauge)
  - all the necessary documentation
- Using the necessary machine tools, tools and measuring instruments

GENERAL PERFORMANCE CRITERIA

- Conformity with occupational health and safety standards
- Mastery of process for manufacturing, assembling and adjusting gauges
- Mastery of techniques for calibrating gauges
- Proper use of measuring instruments used to check tolerances of gauge shapes and positions
- Quality product: conformity of gauges with student's sketches

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
A. Interpret the drawing of the part to be inspected.	- Identification of all the information necessary for making the gauges: • shapes to be checked • dimensions • tolerances • quality of finish - Proper unit of measurement used - Correct interpretation of symbols
B. Design the gauges.	- Design based on the following elements: • cylindrical plug gauge: - shape of gauge - maximum and minimum dimensions - choice of steel - hardness of gauge - quality of finish • adjustable snap gauge - shape of gauge - constituent parts - choice of steel - hardness of parts - quality of finish - assembly and adjustment methods - Design of gauges appropriate to the shapes to be inspected

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
C. Make the sketches.	- Observance of standardized dimensions and tolerances - Clear sketches of gauges and each of their parts - Observance of drafting conventions: • dimensions • cut-away views • symbols • manufacturing notes, allowances and tolerances - Accurate calculation of dimensions - Proper positioning of dimensions on the sketches
D. Produce the planning sheets.	- Complete planning sheet for each part of the gauges, according to: • the routines, subroutines and operations • the types of machines selected for each routine • the tools and testing instruments for each operation • the choice of heat treatments • the sketches dimensioned in machining position for each subroutine • the appropriate symbols for the elimination of degrees of freedom
E. Premachine the components of the gauges.	- Proper use of precision machine tools and accessories - Parts oversized in accordance with their weight and dimensions

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
F. Apply heat treatments.	- Proper choice of temperature and duration of: • quenching • tempering - Hardness accurate to ± 2 HRC - Proper use of hardness tester
G. Do the final machining and inspection of the parts.	- Observance of techniques for using: • finishing machine tools • grinders or laps - Observance of tolerances: • shapes • positions • surfaces • allowances - Neat work
H. Plan the assembly of the snap gauge.	- Complete planning of the following elements of the assembly and subassemblies: • routines, subroutines and operations • the necessary tools for each operation • sketches dimensioned in assembly position for each of the subroutines • observance of symbols for adjustments and allowances
I. Assemble the snap gauge.	- Observance of procedure for assembling the gauge - Observance of tolerances for shapes, positions and allowances in the drawing
J. Adjust the snap gauge.	- Accurate calibration of gauge - Proper functioning of gauge

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to interpret the drawing of the part to be inspected (A):

1. Learn about the targeted competency and the proposed learning process.
2. Apply basic knowledge about drawing.

Before learning how to design the gauges (B):

3. Define the factors that determine the design of a gauge.
4. Recognize the different types of gauge.
5. Recognize the importance of precision and quality of finish in gauges.
6. Interpret the tables for the tolerances applied to gauges.

Before learning how to do the final machining and inspection of the parts (G):

7. Indicate the main inspections to be done on the machines, accessories and measuring instruments.
8. Select the appropriate machine tools for the operations to be done.
9. Select and use high-precision measuring and testing instruments.

Before learning how to plan the assembly of the snap gauge (H):

10. Select the assembly methods and fasteners for a given assembly.

Before learning how to adjust the snap gauge (J):

11. Identify the different methods of calibrating gauges.

MODULE 18: ENTERING THE LABOUR MARKET

CODE: 866 456 **Duration: 90 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
SITUATIONAL OBJECTIVE

EXPECTED OUTCOME

By participating in the required activities of the learning context according to the indicated criteria, the students will be able to
enter the labour market in toolmaking.

SPECIFICATIONS

During this module, the students will:

- Consolidate the competency acquired with respect to the use of job search techniques.
- Become familiar with the performance of toolmakers' tasks in a work setting.
- Situate the role and functions of toolmakers with respect to related roles and functions, such as those of machinists, mouldmakers, diemakers and drafters.
- Become aware of the changes in perception brought about by a toolmaking practicum in the workplace: work context, occupational practices, aptitudes, tastes, interests and training received.

LEARNING CONTEXT

PHASE 1: **Preparation for the Practicum in the Workplace**

- Learning about the competency to be acquired and the terms and conditions of the practicum.

- Learning about the types of companies likely to hire students for a practicum in the workplace.

FIRST-LEVEL OPERATIONAL OBJECTIVE
SITUATIONAL OBJECTIVE

LEARNING CONTEXT

- Learning about the role and functions of toolmakers with respect to related roles and functions, such as those of machinists, mouldmakers, diemakers and drafters.

- Approaching companies likely to hire students for a practicum in the workplace.

PHASE 2: **Participation in Work-related Activities**

- Observing tasks performed by toolmakers.

- Performing certain toolmaking tasks.

- Observing, during their daily tasks, people performing tasks related to those of toolmakers.

- Asking for feedback on their performance and behaviour during the practicum.

- Noting the important aspects of the feedback as well as the other observations made.

PHASE 3: **Comparison of Initial Perceptions with the Reality of the Workplace**

- Listing aspects of the trade that differ from the training received.

- Listing their strengths and weaknesses with respect to their performance and behaviour during the practicum.

- Producing a brief report about the two aspects mentioned above.

- Discussing the accuracy of their perception of the trade before and after the practicum.

- Discussing the consequences of their experience on the rest of their training and their eventual integration into the job market.

FIRST-LEVEL OPERATIONAL OBJECTIVE
SITUATIONAL OBJECTIVE

INSTRUCTIONAL GUIDELINES

The teacher should:

- Create a climate that encourages students to take charge of their learning throughout the modules.
- Maintain close cooperation between the school and businesses likely to hire students for a practicum.
- Provide the students with various information resources during the preparation stage.
- Provide the students with observation and feedback checklists.
- Make sure that the companies provide students with the conditions necessary for performing the activities of the practicum.
- Make sure that there is a person in the company to supervise the student.
- Ensure the proper support and supervision of each student during the practicum.
- Intervene in case of difficulties or problems.
- Promote exchanges of opinion between the students, as well as freedom of expression, particularly when the students are comparing their initial perceptions with the reality of the workplace.

PARTICIPATION CRITERIA

PHASE 1:

- Perform seriously the different activities related to gathering information about the types of companies likely to hire students, as well as the roles and functions of toolmakers and related specialists.
- Contact the companies likely to hire students in order to request an interview with the employer.
- Meet with a representative of the company and come to an agreement in accordance with the requirements of the practicum.
- Inform the teacher in writing of their procedure and of the agreement made with the company.

FIRST-LEVEL OPERATIONAL OBJECTIVE
SITUATIONAL OBJECTIVE

PHASE 2:

- Show an interest and attempt to make relevant observations given the objectives of the practicum.
- Attempt to carefully perform the tasks and operations assigned to them.
- Note properly, on sheets or in their log, the important aspects of the feedback received, as well as their observations on the following:
  - the work of toolmakers
  - the work of specialists in related fields
  - the performance of certain toolmaking tasks

PHASE 3:

- Write a report containing relevant information on:
  - the aspects of the specialty that differ from the training received;
  - the strengths and weaknesses with respect to their behaviour and performance during the practicum.
- Discuss seriously the changes in their perception of the trade following the practicum.
- Show an interest in using their experience in the workplace to improve their behaviour and performance at work.

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before undertaking the activities of Phase 1:

1. Use job search techniques.
2. List the attitudes required for a dynamic practicum search.

Before undertaking the activities of Phase 2:

3. Describe the main aspects to observe during the practicum.
4. Describe the behaviour to adopt in the workplace.
5. Describe the purpose and characteristics of effective feedback.

Before undertaking the activities of Phase 3:

6. List their aptitudes, preferences and interests.

MODULE 19: MAKING A CUTTING TOOL

CODE: 866 576 **Duration: 90 hours**

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must
manufacture, assemble and adjust a cutting tool
in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Given:
  - the drawing of a part to be machined using a cutting tool, with at least one concave shape and one convex shape, and parallel and perpendicular connections
  - all the necessary documentation
- Using the necessary materials, machine tools, tools and measuring instruments

GENERAL PERFORMANCE CRITERIA

- Conformity with occupational health and safety standards
- Mastery of process for manufacturing a high-speed steel or carbide cutting tool
- Proper use of measuring instruments used to check shapes of tools and clearance angles
- Quality product: conformity of part with sketch made by the student

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
A. Interpret the drawing of the part to be machined.	- Identification of all the information necessary for making the part: • shapes • types of materials used • hardness of part • machining symbols • tolerances - Proper unit of measurement - Proper interpretation of symbols
B. Design the cutting tool.	- Proper choice of cutting tool and size - Accurate determination of shape of tool - Proper choice of steel and carbide for the cutting tool - Proper choice of method of fastening the carbide to the steel - Proper choice of system for mounting the tool on the machine
C. Make the sketches.	- Clear sketch of cutting tool - Observance of drawing conventions: • dimensions • cut-away views • symbols • manufacturing notes, allowances and tolerances - Accurate calculation of dimensions - Proper positioning of dimensions on the sketches

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
D. Produce the planning sheet.	- Complete planning sheet for each part of the tool, according to: • the routines, subroutines and operations • the types of machines selected for each routine • the tools and testing instruments for each operation • the choice of heat treatments • the sketches dimensioned in machining position for each subroutine • the appropriate symbols for the elimination of degrees of freedom • methods of fastening the carbide to the toolholder
E. Premachine the parts of the cutting tool.	- Proper use of machine tools and accessories - Observance of machining technique for preparing the tool for heat treatments or brazing
F. Apply heat treatments.	- Proper choice of temperature and duration: • quenching • tempering - Hardness accurate to ±2 HRC - Proper use of hardness tester

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
G. Plan the assembly.	- Complete planning of the following elements of the assembly and subassemblies: • routines, subroutines and operations • the necessary tools for each operation • sketches dimensioned in assembly position for each of the subroutines • observance of symbols for positioning and fastening the tool
H. Weld the carbides to the core of the tool.	- Correct use of: • gas welding system • silver or bronze brazing • the proper flux • the proper heating temperature - Proper positioning of carbide on core - Appropriate fastening method for temporary assembly during brazing
I. Do the final machining and inspection of the tool.	- Observance of techniques for using: • surface and cylindrical grinders • aluminum oxide or diamond grinding wheels • coolants - Proper mounting of tool on machine during manufacture - Observance of tolerances: • shapes • positions • surfaces - Neat work

FIRST-LEVEL OPERATIONAL OBJECTIVE

BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	**SPECIFIC PERFORMANCE CRITERIA**
J. Sharpen cutting tools and wheels.	- Proper selection of accessories and positions for sharpening - Accurate interpretation of terminology related to cutting wheels and tools - Observance of techniques for grinding cutting wheels - Proper use of testing instruments

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS:

Before learning how to interpret the drawing of the part to be machined (A):

1. Learn about the targeted competency and the proposed learning process.
2. Apply basic knowledge about drawing.

Before learning how to design the cutting tool (B):

3. Recognize the different types of cutting tools.
4. Select the grades of carbide.

Before learning how to weld the carbides to the core of the tool (H):

5. Differentiate between gas welding and arc welding.
6. Apply basic knowledge about gas welding.
7. Recognize the purpose of flux in welding.
8. Recognize the main materials used in welding.

Before learning how to do the final machining and inspection of the tool (I):

9. Choose the necessary methods and accessories to assemble a tool.
10. Choose the necessary grinding wheels to grind the shapes of a tool.
11. Interpret the tables of clearance angles for cutting tools.

Before learning how to sharpen cutting tools and wheels (J):

12. Be familiar with how the machine works.
13. Choose the method for fastening the tool to be sharpened.
14. Choose the different types of supports.
15. Adjust the height of the tool and the clearance angles.

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