## Western Technical College

# 31420326  CNC Mill Setup

## Course Outcome Summary

### Course Information

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|---|---|
| **Description** | The setup of CNC (Computer Numerical Control) machining centers is covered in this course. Applications include selection of tools and workholding devices, setting tool offsets and work coordinate positions, calling programs, proofing programs and minor edits and machine adjustments. |
| **Career Cluster** | Manufacturing |
| **Instructional Level** | Technical Diploma Courses |
| **Total Credits** | 1.00 |
| **Total Hours** | 36.00 |

### Types of Instruction

| Instruction Type | Credits/Hours |
|---|---|
| Lecture | 1 CR / 36 HR |

### Course History

#### Purpose/Goals

This course prepares learners to setup CNC mills and machining centers.

#### Target Population

This course is targeted toward individuals who would like to learn to setup computer numerically controlled (CNC) mills and machining centers. This course is designed for incumbent workers, displaced workers, low-income workers who would like to improve employability and skills, high school graduates, and individuals in need of application based employer demanded skills. Additionally, this course is designed to help learners meet the requirements for entry into Western Technical College's machine tool technical diploma program and the requirements to earn a "CNC Setup" certificate as part of a CNC Skills Institute.

#### Pre/Corequisites

Pre/Corequisite    31420315 CNC Production Mill-Operation

#### Learner Supplies

Safety glasses with side eye protection that meet Z87 OSHA guidelines. **Vendor:** Campus Shop. Required.

Proper work boots - $35.00-75.00. **Vendor:** To be discussed in class. Required.

Scientific calculator (recommend T1-36x Solar). **Vendor:** Campus Shop. Required.

## Program Outcomes

1.      **MACH 1. Apply basic safety practices in the machine shop**
        *Type*      *TSA*              *Status*    *Active*

        **Summative Assessment Strategies**
        1.1.      in a performance demonstration in the machine shop or lab
        1.2.      in a written examination

        **Criteria**
        1.1.      Demonstrate safety procedures
        1.2.      Operate machine with all required guards in place
        1.3.      Maintain clean and organized work environment
        1.4.      Wear appropriate clothing and Personal Protective Equipment (PPE)
        1.5.      Explain proper lock-out tag-out procedures

2.      **MACH 2.  Interpret industrial/engineering drawings**
        *Type*      *TSA*              *Status*    *Active*

        **Summative Assessment Strategies**
        2.1.      in a performance demonstration

        **Criteria**
        2.1.      Interpret orthographic projections
        2.2.      Interpret lines, symbols, standards, and notations
        2.3.      Interpret a Bill of Materials
        2.4.      Interpret a title block
        2.5.      Determine location of part features according to established specifications
        2.6.      Calculate tolerances according to established specifications
        2.7.      Develop drawings that follow view projection standards
        2.8.      Interpret Geometric Dimensioning and Tolerancing

3.      **MACH 3.  Apply precision measuring methods to part inspection**
        *Type*      *TSA*              *Status*    *Active*

        **Summative Assessment Strategies**
        3.1.      in a performance demonstration

        **Criteria**
        3.1.      Select correct measuring tool for job requirements
        3.2.      Demonstrate care of precision measuring equipment according to established procedures
        3.3.      Convert English/metric measurements
        3.4.      Use standard industry measurement terminology
        3.5.      Perform precision measurement according to established procedures
        3.6.      Complete an inspection document to verify print specifications
        3.7.      Use computer aided metrology

4.      **MACH 5.  Perform programming, set-up and operation of CNC Machine Tools**
        *Type*      *TSA*              *Status*    *Active*

        **Summative Assessment Strategies**
        4.1.      in a performance demonstration

        **Criteria**
        4.1.      Write basic programs for specified CNC machine tools according to EIA-ISO standards
        4.2.      Load the correct program into the machine

| 4.3. | Verify the accuracy of the CNC program |
| 4.4. | Verify work and tool offsets |
| 4.5. | Execute program |
| 4.6. | Adjust speeds and feeds to optimize CNC machining conditions |

## Course Competencies

**1. Detail CNC programming methods for setting up CNC milling machines**

*Domain* Cognitive *Level* Comprehensi *Status* Active
on

**Assessment Strategies**
1.1. In the classroom, lab, or shop setting
1.2. Using interactive computer software and/or actual CNC machine tools
1.3. In written and applied assignments
1.4. Individually
1.5. On tests and quizzes
1.6. Given program examples, templates, materials, and all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*
1.1. learner correctly identifies the elements of a typical conversational program on the machine control
1.2. learner sequentially and completely lists and describes the elements in a conversational program
1.3. learner sequentially and completely lists and describes the three main sections of a G&M code program
1.4. learner sequentially and completely lists the major processes required for setting up machines that are programmed conversationally
1.5. learner sequentially and completely lists the major processes required for setting up machines that are programmed using G&M codes
1.6. learner successfully completes MasterTask CNC Mills Module 12 interactive test
1.7. learner successfully completes MasterTask CNC Mills Module 14 interactive test
1.8. learner completes all activities with a minimum of 70% accuracy
1.9. learner scores a minimum of 70% on assignments, tests, and quizzes

**Learning Objectives**
1.a. Identify differences related to conversational programming for different machine brands
1.b. Define the elements in conversational programs
1.c. Explain the major sections of G&M code programs
1.d. Describe the major processes required for setting up a machine that uses conversational programming
1.e. Describe the major processes required for setting up a machine that uses G&M code programming
1.f. Analyze similarities between G&M code programs and conversational code programs

**2. Utilize CNC milling machine controls to perform machine start up**

*Domain* Cognitive *Level* Application *Status* Active

**Assessment Strategies**
2.1. In the classroom, lab, or shop setting
2.2. Using actual CNC machine tools
2.3. In written and applied assignments
2.4. Individually
2.5. On tests and quizzes
2.6. Given all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*
2.1. learner follows safety procedures 100% of the time when starting up machines
2.2. learner correctly locates and describes the function of main machine controls on manual CNC milling machines
2.3. learner correctly locates and describes the function of main machine controls on CNC machining centers
2.4. learner sequentially and accurately lists and describes the steps required to start and home manual CNC milling machines

2.5.       learner sequentially and accurately lists and describes the steps required to start and home CNC machining centers

2.6.       learner correctly demonstrates the ability to start and home all CNC milling machines in the machine tool lab or shop

2.7.       learner correctly demonstrates the use jog controls on all CNC milling machines in the machine tool lab or shop

2.8.       learner follows documented procedures to warm up the CNC machining center

2.9.       learner successfully completes MasterTask CNC Mills Module 21 interactive test

2.10.     learner completes all activities with a minimum of 70% accuracy

2.11.     learner scores a minimum of 70% on assignments, tests, and quizzes

**Learning Objectives**

2.a.       Observe safe operating procedures for machine start up

2.b.       Locate and identify the main machine controls on CNC milling machines

2.c.       Describe the process for starting and homing CNC milling machines

2.d.       Demonstrate the process and procedures for starting and homing CNC milling machines

2.e.       Perform CNC machining center warm up

2.f.       Locate and describe the use of jog controls

2.g.       Demonstrate the use of jog controls

## 3.      Plan setups for CNC milling machines

*Domain*   Cognitive       *Level*     Application     *Status*   Active

**Assessment Strategies**

3.1.       In the classroom, lab, or shop setting

3.2.       Using interactive computer software and/or actual CNC machine tools

3.3.       In written and applied assignments

3.4.       Individually

3.5.       On tests and quizzes

3.6.       Given prints, diagrams, process sheets, materials, and all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*

3.1.       learner uses prints to correctly determine required machining processes

3.2.       learner uses prints to correctly locate X, Y and Z part reference datums

3.3.       learner correctly selects tooling for jobs

3.4.       learner accurately calculates stock requirements for jobs

3.5.       learner accurately completes a process plan

3.6.       learner correctly determines workholding device for stock

3.7.       learner correctly determines the required setups for the part

3.8.       learner documents setups with correct location and orientation of part or stock

3.9.       learner plans stock or work set up with the correct amount of stock above the vise to prevent tool crashes

3.10.     learner plans set up of fixturing or clamps in a safe location to avoid tool interference

3.11.     learner plans setups for multiple fixtures or workholding devices

3.12.     learner successfully completes MasterTask CNC Mills Module 43 interactive test

3.13.     learner successfully completes MasterTask CNC Mills Module 44 interactive test

3.14.     learner successfully completes MasterTask CNC Mills Module 45 interactive test

3.15.     learner successfully completes MasterTask CNC Mills Module 46 interactive test

3.16.     learner completes all activities with a minimum of 70% accuracy

3.17.     learner scores a minimum of 70% on assignments, tests, and quizzes

**Learning Objectives**

3.a.       Analyze prints to determine machining processes

3.b.       Analyze prints to determine the number of setups required

3.c.       Locate reference datums

3.d.       Determine material requirements

3.e.       Determine machining sequences for milled parts

3.f.       Determine if multiple setups are required

3.g.       Determine if fixtures are required for setups

3.h.       Document the machining sequences for parts

3.i.     Determine tooling to be used for part machining
3.j.     Determine locations of setup on CNC mill table
3.k.     Determine orientation of setup on CNC mill table
3.l.     Determine the locations for multiple setups on mill tables

## 4.     Perform work setups in CNC milling machines
*Domain     Psychomotor     Level     Practice     Status     Active*

**Assessment Strategies**
4.1.     In the classroom, lab, or shop setting
4.2.     Using actual CNC machine tools
4.3.     In written and applied assignments
4.4.     Individually
4.5.     On tests and quizzes
4.6.     Given prints, diagrams, materials, and all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*
4.1.     learner follows safety procedures 100% of the time when setting up work in machines
4.2.     learner selects the appropriate stock for a given job
4.3.     learner removes all burrs and debris from stock before setting up in machine
4.4.     learner pre-machines edges of stock when required to ensure safe workholding
4.5.     learner correctly secures work in workholding device
4.6.     learner places stock in fixture or on table in correct location relative to part documentation
4.7.     stock extends the specified safe distance from the top of the workholding device
4.8.     clamps and fixtures will not be hit by tools or holders during machine movements
4.9.     stock setup meets parallel and perpendicular alignment requirements
4.10.    stock is setup in the correct orientation relative to part documentation
4.11.    learner correctly performs edge finding procedures
4.12.    learner correctly performs center finding procedures using dial indicator
4.13.    learner correctly sets part zero reference for X axis
4.14.    learner correctly sets part zero reference for Y axis
4.15.    learner completes all activities with a minimum of 70% accuracy
4.16.    learner scores a minimum of 70% on assignments, tests, and quizzes

**Learning Objectives**
4.a.     Observe safe operating procedures for setting up work in CNC machines
4.b.     Select stock for jobs
4.c.     Prepare stock for setting up in the CNC milling machine
4.d.     Secure workholding device on CNC milling machine table
4.e.     Align workholding device on CNC milling machine table
4.f.     Locate and align multiple workholding devices in CNC milling machine
4.g.     Set up alternate workholding fixtures in or on vices
4.h.     Secure stock in CNC milling machine workholding device
4.i.     Check the stock alignment
4.j.     Use an edgefinder to find the X and Y coordinates for the edge of the part
4.k.     Use a dial indicator and Indicol to find the center of the workpiece
4.l.     Set up stock to avoid interference between workholding and tooling

## 5.     Perform tool setups in CNC milling machines
*Domain     Psychomotor     Level     Practice     Status     Active*

**Assessment Strategies**
5.1.     In the classroom, lab, or shop setting
5.2.     Using interactive computer software and/or actual CNC machine tools
5.3.     In written and applied assignments
5.4.     Individually
5.5.     On tests and quizzes
5.6.     Given prints, diagrams, materials, and all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*

5.1.     learner follows safety procedures 100% of the time when setting tools up in machines
5.2.     learner correctly determines tools needed for specific applications or jobs
5.3.     learner correctly locates tools in tool library
5.4.     learner calls up tools from tool library
5.5.     learner correctly specifies tool number and offset for each tool
5.6.     learner sets up tools in correct slot in CNC machining center tool carousel or magazine
5.7.     learner performs tool touch offs on top of part and correctly enters offsets on manual CNC milling machines
5.8.     learner performs tool touch offs on top of part and correctly enters offsets on automatic CNC machining centers
5.9.     learner performs tool touch offs using reference tool and correctly enters offsets in CNC milling machine offset page
5.10.    learner performs tool touch offs using set up block and correctly enters offsets in CNC milling machine offset page
5.11.    learner enters correct dimensions for diameter or radius offsets
5.12.    learner completes tool identification and offset sheet with a minimum of 70% accuracy
5.13.    learner correctly demonstrates the use of tool presetter to set tool offsets
5.14.    learner successfully completes MasterTask CNC Mills Module 31 interactive test
5.15.    learner successfully completes MasterTask CNC Mills Module 56 interactive test
5.16.    learner successfully completes MasterTask CNC Mills Module 57 interactive test
5.17.    learner successfully completes MasterTask CNC Mills Module 58 interactive test
5.18.    learner successfully completes MasterTask CNC Mills Module 59 interactive test
5.19.    learner completes all activities with a minimum of 70% accuracy
5.20.    learner scores a minimum of 70% on assignments, tests, and quizzes

**Learning Objectives**

5.a.     Observe safe operating procedures for setting up tools in CNC machines
5.b.     Use machine controls to locate tool library and offset pages
5.c.     Locate tools in tool library
5.d.     Describe tools for given applications
5.e.     Identify end mill types relative to actual tools
5.f.     Determine tools needed for specific jobs from specification or process sheet
5.g.     Set up tools in holder for manual CNC
5.h.     Load tools in carousel or magazine
5.i.     Explain each of the methods used for offsetting tool lengths in CNC milling machines
5.j.     Demonstrate three methods for offsetting tool lengths in CNC milling machines
5.k.     Set tool offsets for all tools in programs to be ran
5.l.     Explain the use of tool presetters
5.m.     Demonstrate the use of tool presetters

**6.      Call up programs to run in CNC milling machines**
*Domain    Psychomotor    Level    Practice    Status    Active*

**Assessment Strategies**

6.1.     In the classroom, lab, or shop setting
6.2.     Using interactive computer software and/or actual CNC machine tools
6.3.     In written and applied assignments
6.4.     Individually
6.5.     On tests and quizzes
6.6.     Given prints, process sheets, directions, and all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*

6.1.     learner correctly describes the methods used for storing CNC programs on external devices and equipment
6.2.     learner correctly describes the methods used for storing CNC programs in the machine control unit
6.3.     learner correctly demonstrates the process for loading programs in each CNC milling machine in the machine tool lab or shop
6.4.     learner correctly demonstrates the process to activate or call up programs from each CNC milling

machine in the machine tool lab or shop

6.5.    learner correctly demonstrates the process to delete programs from each CNC milling machine in the machine tool lab or shop
6.6.    learner successfully completes MasterTask CNC Mills Module 28 interactive test
6.7.    learner successfully completes MasterTask CNC Mills Module 29 interactive test
6.8.    learner successfully completes MasterTask CNC Mills Module 30 interactive test
6.9.    learner completes all activities with a minimum of 70% accuracy
6.10.   learner scores a minimum of 70% on assignments, tests, and quizzes

**Learning Objectives**
6.a.    Describe program storage methods for CNC milling machines
6.b.    Operate controls for selecting, activating, and loading programs
6.c.    Load programs from a disk
6.d.    Load programs from a USB drive
6.e.    Describe program loading options
6.f.    Locate stored programs
6.g.    Activate programs from control memory
6.h.    Delete programs

## 7.    Verify programs graphically in CNC milling machines
*Domain    Psychomotor    Level    Practice    Status    Active*

**Assessment Strategies**
7.1.    In the classroom, lab, or shop setting
7.2.    Using actual CNC machine tools
7.3.    In written and applied assignments
7.4.    Individually
7.5.    On tests and quizzes
7.6.    Given prints, process sheets, specification sheets, and all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*
7.1.    learner correctly demonstrates the process for verifying programs in the graphical interface of every CNC milling machine in the machine tool lab or shop
7.2.    learner follows the correct sequence of steps to select and activate specific programs
7.3.    learner views graphical display and determines program accuracy
7.4.    learner correctly identifies and corrects errors in programs
7.5.    learner follows correct procedures to resize the grid on the graphics screen on manual CNC milling machines
7.6.    learner follows correct procedures to resize the graphical display on automatic CNC machining centers to zoom in or out on parts
7.7.    learner completes all activities with a minimum of 70% accuracy
7.8.    learner scores a minimum of 70% on assignments, tests, and quizzes

**Learning Objectives**
7.a.    Locate and operate controls to verify programs in graphical interface of CNC milling machines
7.b.    Select and activate specified programs
7.c.    Run programs in graphical interface
7.d.    Analyze graphical path to determine program viability
7.e.    Analyze program to locate possible errors
7.f.    Demonstrate process for resizing the graphical interface

## 8.    Run new programs in CNC milling machines
*Domain    Psychomotor    Level    Practice    Status    Active*

**Assessment Strategies**
8.1.    In the machine tool lab or shop setting
8.2.    Using actual CNC machine tools
8.3.    In written and applied assignments
8.4.    Individually
8.5.    On tests and quizzes

8.6.    Given prints, stock, and all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*

8.1.    learner follows safety procedures 100% of the time when running CNC milling machines
8.2.    learner completes new program run check sheet prior to running new programs
8.3.    learner demonstrates the correct sequence to run programs in each type of CNC milling machine in the machine tool lab or shop
8.4.    learner correctly demonstrates the use of the single block function to run programs
8.5.    learner correctly demonstrates the procedures for changing speed and feed settings
8.6.    learner demonstrates the correct use of overrides to run programs for the first time
8.7.    learner references process sheets to verify the correct speed and feed settings
8.8.    learner demonstrates the process for turning the coolant on and off
8.9.    learner determines the correct direction and volume of the coolant flow
8.10.   learner runs a minimum of two different new parts in conversationally controlled CNC milling machines
8.11.   learner runs a minimum of two different new parts in automatic CNC machining centers
8.12.   learner demonstrates the correct procedures for changing tooling and resuming operation on manual CNC machines
8.13.   learner performs inspections before removing part from the machine
8.14.   learner completes all activities with a minimum of 70% accuracy
8.15.   learner scores a minimum of 70% on assignments, tests, and quizzes

**Learning Objectives**

8.a.    Observe safe operating procedures for running CNC milling machines
8.b.    Follow procedures to determine that all steps have been performed prior to running programs
8.c.    Locate and operate controls to run programs in CNC milling machines
8.d.    Use overrides to safely run programs for the first time
8.e.    Use single block function to safely run programs for the first time
8.f.    Verify speed and feed settings
8.g.    Change speed and feed settings
8.h.    Turn coolant on and off
8.i.    Change tools in manual CNC milling machines
8.j.    Resume program run after optional stops
8.k.    Run multiple new part programs in CNC milling machines

**9.    Inspect parts machined in CNC milling machines**
*Domain    Psychomotor    Level    Practice    Status    Active*

**Assessment Strategies**

9.1.    In the classroom, lab, or shop setting
9.2.    Using actual CNC machine tools
9.3.    In written and applied assignments
9.4.    Individually
9.5.    On tests and quizzes
9.6.    Given prints, diagrams, inspection sheets, stock, and all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*

9.1.    learner follows safety procedures 100% of the time when inspecting parts in CNC milling machines
9.2.    learner uses print, specification sheet, or other documentation to determine part sizes
9.3.    learner accurately calculates part tolerances
9.4.    learner correctly identifies surface finish requirements
9.5.    learner performs inspections on all required part surfaces and diameters
9.6.    learner documents part quality problems and lists potential solutions
9.7.    learner demonstrates the use of overrides to improve part surface finish
9.8.    learner accurately completes inspection reports
9.9.    learner completes all activities with a minimum of 70% accuracy
9.10.   learner scores a minimum of 70% on assignments, tests, and quizzes

**Learning Objectives**

9.a.     Use safety precautions when inspecting work in CNC milling machines
9.b.     Perform first part inspections during run
9.c.     Calculate tolerances
9.d.     Determine part acceptability based on tolerances
9.e.     Determine part surface finish quality
9.f.     Analyze problems and suggest solutions
9.g.     Adjust overrides to improve part surface finish
9.h.     Complete first inspection report

## 10.     Perform minor tooling and offset adjustments on CNC milling machines
*Domain     Psychomotor     Level     Practice          Status     Active*

**Assessment Strategies**
10.1.     In the classroom, lab, or shop setting
10.2.     Using actual CNC machine tools
10.3.     In written and applied assignments
10.4.     Individually
10.5.     On tests and quizzes
10.6.     Given prints, diagrams, pictures, inspection sheets, materials, and all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*
10.1.     learner follows safety procedures 100% of the time when adjusting tools and offsets in CNC milling machines
10.2.     learner correctly identifies signs of tool wear on part surfaces
10.3.     learner correctly determines when tool wear or insert damage has occurred
10.4.     learner corrects tooling when indicated
10.5.     learner correctly adjusts the X and/or Y offset to bring part sizes within specified tolerances
10.6.     learner correctly adjusts tool wear and radius offsets to bring part sizes within tolerance
10.7.     learner completely documents all changes to tool offsets and tool changes
10.8.     learner successfully completes MasterTask CNC Mills Module 78 interactive test
10.9.     learner successfully completes MasterTask CNC Mills Module 79 interactive test
10.10.   learner completes all activities with a minimum of 70% accuracy
10.11.   learner scores a minimum of 70% on assignments, tests, and quizzes

**Learning Objectives**
10.a.     Use safety precautions when adjusting tools and offsets on CNC milling machines
10.b.     Adjust tools to correct part quality
10.c.     Adjust offsets to bring part within tolerance
10.d.     Inspect tools for wear and damage
10.e.     Inspect part for indications that tools need changed

## 11.     Restart programs after tooling or offset adjustments
*Domain     Psychomotor     Level     Practice          Status     Active*

**Assessment Strategies**
11.1.     In the classroom, lab, or shop setting
11.2.     Using interactive computer software and/or actual CNC machine tools
11.3.     In written and applied assignments
11.4.     Individually
11.5.     On tests and quizzes
11.6.     Given diagrams, materials, and all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*
11.1.     learner follows safety procedures 100% of the time when restarting CNC milling machines
11.2.     learner sequentially and completely lists the steps required for stopping and restarting programs in CNC milling machines
11.3.     learner uses the search function to correctly locate blocks to restart programs

11.4.     learner places the machine axes in the correct location before restarting programs
11.5.     learner correctly follows all procedures for stopping and restarting programs
11.6.     learner correctly restarts programs after adjusting or replacing tools
11.7.     learner successfully completes MasterTask CNC Mills Module 42 interactive test
11.8.     learner completes all activities with a minimum of 70% accuracy
11.9.     learner scores a minimum of 70% on assignments, tests, and quizzes

**Learning Objectives**

11.a.     Use safe operating procedures when restarting CNC milling machines
11.b.     Describe the procedures for stopping and restarting programs in CNC milling machines
11.c.     Explain manual restart functions
11.d.     Explain automatic restart functions
11.e.     Record stop and start sequences
11.f.     Locate restart block in program
11.g.     Explain the procedure for locating the machine axes in a restart
11.h.     Restart programs