31420330 CNC Mill Operation-Intermediate

Course Outcome Summary

Course Information

Description	Conversational programming and an introduction to G & m code programming of CNC (Computer Numerical Control) machining centers and mills. Program prove-out for production of parts.
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 and operate CNC mills using conversational programming.

Target Population

This course is targeted toward individuals who would like to learn to setup, operate, and write simple conversational and G&M code programs for 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

Prerequisite   Corequisite(s): 31420326 CNC Mill Setup

Textbooks

No textbook required.

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. Interpret basic CNC milling machine programs
Domain *Cognitive*   *Level*   *Analysis*   *Status*   *Active*

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 locates and describes common G&M codes in basic programs
1.2.	learner correctly locates and describes common conversational program codes in programs at the CNC milling machine control display
1.3.	learner correctly differentiates modal and non-modal codes in a written program
1.4.	learner writes an accurate description of the function of specified program elements and codes
1.5.	learner completes a sequential list of CNC functions by following a "roadmap"
1.6.	learner successfully completes MasterTask CNC Mills Module 13 interactive test
1.7.	learner successfully completes MasterTask CNC Mills Module 17 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 common G&M codes
1.b.	Identify common conversational program codes
1.c.	Explain the elements of a program block
1.d.	Describe the actions the CNC milling machine performs for a block of code
1.e.	Explain "modal"
1.f.	Describe the three main CNC machine movements
1.g.	Describe the main function of G codes
1.h.	Describe the main function of M codes
1.i.	Describe the purpose of sequence numbers
1.j.	Follow a CNC program "road map"

2. Apply machining principles when writing programs
Domain *Cognitive*   *Level*   *Application*   *Status*   *Active*

Assessment Strategies
2.1.	In the classroom, lab, or shop setting
2.2.	In written and applied assignments
2.3.	Individually
2.4.	On tests and quizzes
2.5.	Given blank process sheets, templates, references and all available shop equipment and supplies

Criteria

Performance will be satisfactory when:
2.1.	learner accurately and sequentially completes an operation process plan for all programs written
2.2.	learner process plan specifies part name, program number, material, raw stock size and quantity

2.3.   learner process plan sequentially lists the operation, machine, description, and time estimate
2.4.   learner accurately and sequentially completes a setup process plan for all programs written
2.5.   learner process plan specifies part name, program number, and machine to be used
2.6.   learner process plan describes the setup, including workholding and PRZ coordinates
2.7.   learner process plan sequentially lists the tool number, description, offsets and relevant comments
2.8.   learner process plan accurately lists tool speeds, feedrates, and cutting depths
2.9.   learner accurately and sequentially completes a quality control check sheet
2.10. learner control check sheet specifies part name, number, and inspector's name
2.11. learner control check sheet accurately lists critical print dimensions and tolerances
2.12. learner successfully completes MasterTask CNC Mills Module 6 interactive test
2.13. learner completes all activities with a minimum of 70% accuracy
2.14. learner scores a minimum of 70% on assignments, tests, and quizzes

Learning Objectives
2.a.   Explain the importance of machine movement speed to cycle time
2.b.   Explain tool movement relative to cycle time
2.c.   Determine order of operations
2.d.   Determine depth of cut
2.e.   Determine feeds and speeds
2.f.   Select tooling
2.g.   Determine workholding or fixturing
2.h.   Determine coordinate locations relative to machine position
2.i.   Create an operation process plan
2.j.   Create a setup process plan
2.k.   Create a quality inspection plan

3.   **Write basic G&M code programs on a computer**
   Domain   Cognitive   Level   Application   Status   Active

   Assessment Strategies
3.1.   In the classroom, lab, or shop setting
3.2.   Using computers and 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.   accurately types a program using format provided by template
3.2.   learner accurately types a program using a print
3.3.   learner correctly follows directions provided
3.4.   learner saves files as .txt text files
3.5.   learner correctly demonstrates the procedures to verify programs on the CNC milling machine graphical display
3.6.   learner corrects program errors on the CNC milling machine control
3.7.   learner corrects program errors at the computer and re-saves to overwrite program
3.8.   learner uses e-mail to send program files as attachments
3.9.   learner sends instructor original, individually created work
3.10. learner completes all activities with a minimum of 70% accuracy
3.11. learner scores a minimum of 70% on assignments, tests, and quizzes

   Learning Objectives
3.a.   Use a template to write a simple G&M code program
3.b.   Use a print to write a simple G&M code program
3.c.   Verify programs on CNC milling machine graphical display
3.d.   Edit programs in the CNC milling machine control
3.e.   Edit programs at the computer
3.f.   Save programs in specified format
3.g.   Send programs to instructor

4. **Utilize MDI mode to write conversational programs**
   Domain   *Cognitive*   *Level*   *Application*   *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, tutorials, materials, and all available shop equipment and supplies

   Criteria

   Performance will be satisfactory when:
   4.1.   learner writes CNC milling machine programs in the correct mode
   4.2.   learner accurately follows tutorial directions to write a conversational program for a CNC milled part
   4.3.   learner verifies the accuracy of the conversational program in the graphical machine interface
   4.4.   learner saves files as directed
   4.5.   learner completes all activities with a minimum of 70% accuracy
   4.6.   learner scores a minimum of 70% on assignments, tests, and quizzes

   Learning Objectives
   4.a.   Write conversational programs in MDI mode
   4.b.   Write a conversational program using a tutorial
   4.c.   Write a conversational program for an approved part
   4.d.   Verify programs in graphical interface

5. **Utilize MDI mode to write basic G&M code programs**
   Domain   *Cognitive*   *Level*   *Application*   *Status*   *Active*

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

   Criteria

   Performance will be satisfactory when:
   5.1.   learner accurately follows template to write first G&M code program for CNC milled part
   5.2.   learner accurately types programs on a computer
   5.3.   learner writes CNC milling machine program using MDI mode interface
   5.4.   learner verifies the accuracy of the first program in the graphical machine interface
   5.5.   learner sequentially and accurately writes a G&M code program for a second CNC milled part using print specifications
   5.6.   learner verifies the accuracy of the second program in the graphical machine interface
   5.7.   learner saves files as directed
   5.8.   learner completes all activities with a minimum of 70% accuracy
   5.9.   learner scores a minimum of 70% on assignments, tests, and quizzes

   Learning Objectives
   5.a.   Use MDI functions
   5.b.   Write a G&M code program using a template
   5.c.   Write a simple CNC machining center program in G&M code language from an approved part print
   5.d.   Write simple G&M code programs at the machine control on EIA/ISO controlled machines
   5.e.   Verify programs in graphical interface

6. **Create an outline for writing a Mazak machining center program**
   Domain   *Cognitive*   *Level*   *Application*   *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, directions, templates, and all available shop equipment and supplies

Criteria

Performance will be satisfactory when:

6.1. learner views all relevant Mazak videos
6.2. learner accurately completes Mazak process handouts during videos
6.3. learner creates an outline that sequentially and completely describes the steps for writing Mazak machining center programs
6.4. learner successfully completes MasterTask CNC Mills Module 24 interactive test
6.5. learner successfully completes MasterTask CNC Mills Module 25 interactive test
6.6. learner successfully completes MasterTask CNC Mills Module 26 interactive test
6.7. learner successfully completes MasterTask CNC Mills Module 34 interactive test
6.8. learner successfully completes MasterTask CNC Mills Module 35 interactive test
6.9. learner successfully completes MasterTask CNC Mills Module 49 interactive test
6.10. learner successfully completes MasterTask CNC Mills Module 54 interactive test
6.11. learner successfully completes MasterTask CNC Mills Module 64 interactive test
6.12. learner successfully completes MasterTask CNC Mills Module 67 interactive test
6.13. learner successfully completes MasterTask CNC Mills Module 68 interactive test
6.14. learner successfully completes MasterTask CNC Mills Module 69 interactive test
6.15. learner successfully completes MasterTask CNC Mills Module 70 interactive test
6.16. learner successfully completes MasterTask CNC Mills Module 71 interactive test
6.17. learner successfully completes MasterTask CNC Mills Module 72 interactive test
6.18. learner successfully completes MasterTask CNC Mills Module 73 interactive test
6.19. learner successfully completes MasterTask CNC Mills Module 75 interactive test
6.20. learner completes all activities with a minimum of 70% accuracy
6.21. learner scores a minimum of 70% on assignments, tests, and quizzes

Learning Objectives

6.a. Explain the purpose of Mazak programming
6.b. Explain the three principal types of machining units on a Mazak
6.c. Describe the five locations within the Mazak control that holds values used to calculate a sequence
6.d. Explain the four types of units that each Mazak program must contain
6.e. Explain the normal program execution sequence for a Mazak machining center
6.f. Describe Mazak priority machining
6.g. Explain the information found in Mazak tool data and tool file displays
6.h. Explain the relationship between tool data locations and pocket numbers on the tool magazine
6.i. Identify the workpiece materials and tool material tables within the cutting conditions page on Mazak controls
6.j. Explain how to locate and enter program zero on a Mazak conversational control
6.k. Explain how and when EIA codes can be used within a Mazak part program
6.l. Explain Mazak drilling units
6.m. Explain Mazak units for tapping
6.n. Describe Mazak boring sequences
6.o. Describe Mazak boring units
6.p. Describe Mazak circular milling
6.q. Describe Mazak reaming units
6.r. Describe Mazak line milling units
6.s. Describe how to enter data into a Mazak line unit
6.t. Describe the difference between Mazak unidirectional and bidirectional tool path movements
6.u. Explain the Mazak graphic display functions used during programming
6.v. Detail the process of writing a new Mazak program

7. Edit programs on 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 identifies errors or codes requiring change in conversational programs
7.2.   learner correctly identifies errors or codes requiring change in G&M code programs
7.3.   learner correctly identifies and describes each edit mode function on conversational CNC milling machines
7.4.   learner correctly identifies and describes each edit mode function on G&M code CNC machining centers
7.5.   learner demonstrates ability to find programs that require editing
7.6.   learner selects the correct program for editing
7.7.   learner demonstrates ability to edit conversational programs on CNC milling machines
7.8.   learner demonstrates ability to edit G&M code programs in edit mode on CNC machining centers
7.9.   learner completes all activities with a minimum of 70% accuracy
7.10.   learner scores a minimum of 70% on assignments, tests, and quizzes

Learning Objectives
7.a.   Analyze conversational programs for errors requiring changes
7.b.   Select programs in Edit mode on conversationally controlled CNC milling machines
7.c.   Use edit mode functions on conversational CNC milling machines
7.d.   Edit programs on conversationally controlled CNC milling machines
7.e.   Analyze G&M code programs for errors or required changes
7.f.   Select programs for editing in Edit mode on CNC machining centers
7.g.   Use edit mode functions on EIA/ISO controlled CNC machining centers
7.h.   Edit G&M code programs on EIA/ISO controlled CNC machining centers

8.   Transfer programs from external devices to CNC milling machine memory
Domain   Psychomotor   Level   Practice   Status   Active

Assessment Strategies
8.1.   In the classroom, lab, or shop setting
8.2.   Using computers and actual CNC machine tools
8.3.   In written and applied assignments
8.4.   Individually
8.5.   On tests and quizzes
8.6.   Given logs and all available shop equipment and supplies

Criteria

Performance will be satisfactory when:

8.1.   learner identifies a minimum of four external storage devices for CNC programs
8.2.   learner describes at least two places to back up program files
8.3.   learner creates a file directory path for milling programs
8.4.   learner follows a directory path to retrieve milling programs with no more than one misstep
8.5.   learner locates files on a computer in less than 10 seconds
8.6.   learner names all program files using correct protocol
8.7.   learner backs up all program files on the student server
8.8.   learner saves all files on a flash drive
8.9.   learner saves all text files on a floppy disk
8.10.   learner records all file names and descriptions in a logbook
8.11.   learner correctly demonstrates the process for sending files to the CNC machine from a computer
8.12.   learner correctly demonstrates the process for transferring files from a floppy disk or USB drive to the CNC machine

8.13.   learner locates recently transferred files in the CNC machine directory and activates them in the machine memory mode
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.   Describe external storage devices for CNC programs
8.b.   Describe methods used to transfer programs to CNC machines
8.c.   Describe naming protocols for files
8.d.   Locate files in a directory
8.e.   Backup program files
8.f.   Send programs from computer to machine tool
8.g.   Transfer programs to machine memory

9.   Prove out programs
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 working in the vicinity of CNC milling machines
9.2.   learner completes a check list for each new program before running in the CNC milling machine
9.3.   learner demonstrates the correct procedures for proving every new program or setup
9.4.   learner checks for correct positioning of tools to the part prior to proving programs
9.5.   learner ensures all tools are a safe distance from the workpiece or other machine parts prior to proving programs
9.6.   learner re-checks all new programs in the graphical interface
9.7.   learner correctly demonstrates the process of checking program by removing the workpiece and "cutting air"
9.8.   learner correctly demonstrates the process of checking programs by using the single block function to ensure safe operation of every block
9.9.   learner turns rapid to less than 25% for proving programs
9.10.   learner turns feedrates and spindles speeds to 50% or less for proving programs
9.11.   learner stops the operation of the machine and checks dimensions after each operation
9.12.   learner follows correct procedures for restarting the machine after each stop during the operation of the program
9.13.   learner checks overall part finish and quality after proving each part
9.14.   learner accurately documents dimensions and part quality comments for each first run part
9.15.   learner completes all activities with a minimum of 70% accuracy
9.16.   learner scores a minimum of 70% on assignments, tests, and quizzes

Learning Objectives
9.a.   Use safety precautions when starting and running CNC milling machines
9.b.   Complete program check list prior to proving programs
9.c.   Follow specified procedures for proving out programs
9.d.   Check positioning of tools and parts
9.e.   Check programs by using graphical interface
9.f.   Check programs by "cutting air"
9.g.   Check programs using single block function
9.h.   Check part quality for each operation
9.i.   Check part quality for first run parts
9.j.   Use machine overrides to control machine speed and feedrates

10.   Run programs in 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 setting up and running CNC milling machines
10.2.   learner selects correct program to run for a given application
10.3.   learner selects correct tooling to use for specific programs
10.4.   learner correctly loads tools for each program operation
10.5.   learner selects appropriate stock for specific program
10.6.   learner safely secures work in CNC milling machine for specific program runs
10.7.   learner correctly demonstrates first run operating procedures for each new program
10.8.   learner runs conversational tutorial program in CNC milling machine
10.9.   learner runs first user-programmed G&M code program in CNC machining center
10.10.   learner runs second user-programmed G&M code program in CNC machining center
10.11.   learner runs a minimum of two pre-programmed programs from the CNC milling machine memory
10.12.   learner completes all activities with a minimum of 70% accuracy
10.13.   learner scores a minimum of 70% on assignments, tests, and quizzes

Learning Objectives
10.a.   Use safety precautions when setting up and running CNC turning machines
10.b.   Set up CNC milling machines to run programs
10.c.   Select programs to run in CNC milling machines
10.d.   Follow procedures for first part runs
10.e.   Run programs in conversationally controlled CNC milling machines
10.f.   Run programs in EIA/ISO controlled CNC milling machines

11.   Use offsets to correct dimensional errors on milled parts
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 adjusting, setting up, or running CNC milling machines
11.2.   learner correctly determines dimensions that are out of specification
11.3.   learner correctly identifies the most likely cause of out of tolerance dimensions
11.4.   learner selects the correct sign for inputting offset values
11.5.   learner selects the correct offset column and row for inputting offset values
11.6.   learner selects the correct coordinate axis for inputting offset values
11.7.   learner demonstrates offset corrections for all types of CNC milling machines in the machine tool lab or shop
11.8.   learner correctly demonstrates the process for adjusting offsets after changing cutting tools or inserts
11.9.   learner correctly demonstrates the process for adjusting offsets for cutting tool wear factors
11.10.   learner re-runs programs after adjusting offsets

11.11.   learner repeats inspection and offset processes until all programs produce parts of acceptable quality

11.12.   learner successfully completes MasterTask CNC Mills Module 32 interactive test

11.13.   learner successfully completes MasterTask CNC Mills Module 61 interactive test

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

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

Learning Objectives

11.a.   Use safe operating procedures when setting up or running CNC milling machines

11.b.   Inspect first run parts

11.c.   Use inspection reports to determine corrective actions

11.d.   Compare actual part dimensions to print dimensions

11.e.   Analyze part quality

11.f.   Explain the effect of tool offsets on part geometry

11.g.   Explain the relationship of programmed tool path and the spindle center point and radius offset value

11.h.   Explain the types of tools to which a radius offset can be applied

11.i.   Differentiate between tool radius and diameter as they apply to offsets

11.j.   Explain the importance of using wear offsets as opposed to adjusting geometry offsets

11.k.   Describe how preset tools affect the offset process

11.l.   Describe considerations required before making offset adjustments

11.m.   Explain the effect of changes to cutter radius compensation values relative to the workpiece

11.n.   Demonstrate how to locate offset screens using various CNC milling center machine controls

11.o.   Perform offset adjustments to establish part tolerances for first part

11.p.   Change tooling and adjust offsets

11.q.   Verify corrective actions by repeating program runs

11.r.   Complete inspection reports