

**Western Technical College**

**31420362 CNC Advanced Programming**

**Course Outcome Summary**

**Course Information**

<b>Description</b>	Advanced level programming for CNC turning and machining centers with program prove out. Participants will write multiple operation programs at the machine and computer, enter offsets and tool comp and machine parts to prove out programs.
<b>Career Cluster</b>	Manufacturing
<b>Instructional Level</b>	Technical Diploma Courses
<b>Total Credits</b>	2.00
<b>Total Hours</b>	72.00

**Types of Instruction**

<b>Instruction Type</b>	<b>Credits/Hours</b>
Lecture	1 CR / 36 HR
Lab	1 CR / 36 HR

**Course History**

**Textbooks**

*420-310 CNC Programming Manual Machine Tool.* Western. Publisher: Western. 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.

**Core Abilities**

1. **Apply mathematical concepts.**  
*Status Active*
  
2. **Demonstrate ability to think critically.**  
*Status Active*

3. **Demonstrate ability to value self and work ethically with others in a diverse population.**  
*Status Active*
4. **Make decisions that incorporate the importance of sustainability.**  
*Status Active*
5. **Transfer social and natural science theories into practical applications.**  
*Status Active*
6. **Use effective communication skills.**  
*Status Active*
7. **Use technology effectively.**  
*Status Active*

## Program Outcomes

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

### 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 WIP*

### 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 WIP*

### 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*      *WIP*

**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. Apply safety procedures to lab applications**

*Domain*    *Psychomotor*      *Level*      *Practice*                      *Status*      *WIP*

**Linked Core Abilities**

Use effective communication skills.  
Use technology effectively.

**Linked Program Outcomes**

MACH 1. Apply basic safety practices in the machine shop  
MACH 5. Perform programming, set-up and operation of CNC Machine Tools

**Assessment Strategies**

- 1.1. In the classroom, lab, or shop setting
- 1.2. In written and applied assignments
- 1.3. Individually and in groups
- 1.4. On tests and quizzes
- 1.5. Given materials and all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*

- 1.1. wears safety glasses 100% of the time while in the machine tool lab
- 1.2. learner puts tools and tooling away after use
- 1.3. learner works with others to keep coolant and fluid levels filled
- 1.4. learner dresses appropriately for CNC machine shop
- 1.5. learner corrects safety hazards in and around the machine tool lab
- 1.6. learner explains when machine tools need a warm-up cycle
- 1.7. learner uses safe methods to secure workpieces in machine tools
- 1.8. learner practices safe procedures for operating the machine tools
- 1.9. learner does not use compressed air inside or on machine tools
- 1.10. learner describes shut-down procedures for machine tools
- 1.11. learner cleans machines after use
- 1.12. safety procedures meet the rubric criteria a minimum of 75% for each criteria
- 1.13. learner scores 90% or higher on safety test

**Learning Objectives**

- 1.a. Wear safety glasses in the lab
- 1.b. Maintain clean work area
- 1.c. Adhere to machine maintenance schedule
- 1.d. Identify CNC shop safety hazards
- 1.e. Follow procedures for machine warm-up, set-up, operation, and shut down
- 1.f. Respect machine tools and equipment

## 2. Identify standard and auxiliary machine tool axes

<i>Domain</i>	<i>Cognitive</i>	<i>Level</i>	<i>Comprehension</i>	<i>Status</i>	<i>WIP</i>
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### Linked Core Abilities

Apply mathematical concepts.  
Demonstrate ability to think critically.

### Linked Program Outcomes

MACH 2. Interpret industrial/engineering drawings  
MACH 5. Perform programming, set-up and operation of CNC Machine Tools

### Assessment Strategies

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

### Criteria

*Performance will be satisfactory when:*

- 2.1. learner correctly locates X, Y and Z axes of part when writing programs
- 2.2. learner correctly places workpiece in CNC machining center relative to print specifications
- 2.3. learner tabulates coordinates from prints for CNC machining center assignments
- 2.4. learner tabulates coordinates using absolute positioning
- 2.5. learner tabulates coordinates using incremental positioning
- 2.6. assignments are turned in by due date and have accuracy of 70% or higher
- 2.7. tests and quizzes have a minimum of 70% correct answers

### Learning Objectives

- 2.a. Differentiate various axis coordinate systems for CNC machining centers
- 2.b. Identify standard CNC machining center axes
- 2.c. Identify auxiliary CNC machining center axes
- 2.d. Illustrate CNC machining center axis motions
- 2.e. Tabulate X, Y and Z coordinates for machining centers
- 2.f. Differentiate incremental and absolute axes and movements on CNC machining centers
- 2.g. Orient workpieces in CNC machining center relative to part print specifications

## 3. Describe terminology associated with CNC machining center programming

<i>Domain</i>	<i>Cognitive</i>	<i>Level</i>	<i>Comprehension</i>	<i>Status</i>	<i>WIP</i>
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### Linked Core Abilities

Demonstrate ability to think critically.  
Use technology effectively.

### Linked Program Outcomes

MACH 1. Apply basic safety practices in the machine shop  
MACH 5. Perform programming, set-up and operation of CNC Machine Tools

### Assessment Strategies

- 3.1. In the classroom, lab, or shop setting
- 3.2. Using actual CNC machine tools
- 3.3. In written and applied assignments
- 3.4. Individually
- 3.5. On tests and quizzes
- 3.6. Given prints, materials, and all available shop equipment and supplies

### Criteria

*Performance will be satisfactory when:*

- 3.1. learner participates in classroom discussion on terminology related to CNC machining
- 3.2. learner scores 70% or greater on terminology quiz
- 3.3. learner uses the correct terms for CNC machining center system components
- 3.4. learner correctly identifies print symbols as they relate to CNC machining
- 3.5. learner correctly describes the function of CNC general preparatory codes for machining centers
- 3.6. learner correctly describes the function of miscellaneous CNC codes for machining centers
- 3.7. learner interprets prints to write CNC machining center programs
- 3.8. learner selects appropriate tools for CNC milling machine processes
- 3.9. assignments have accuracy of 70% or higher
- 3.10. learner describes CNC machining center codes other than G and M codes

#### **Learning Objectives**

- 3.a. Identify terms related to CNC milling machines
- 3.b. Describe CNC machining center word address terms
- 3.c. Explain G and M code terms related to CNC machining center programming
- 3.d. Identify print terms related to CNC machining
- 3.e. Differentiate tooling terms as they relate to CNC machining centers

#### **4. Interpret G, M, and other programming code functions**

<i>Domain</i>	<i>Cognitive</i>	<i>Level</i>	<i>Analysis</i>	<i>Status</i>	<i>WIP</i>
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#### **Linked Core Abilities**

Apply mathematical concepts.  
 Demonstrate ability to think critically.  
 Use technology effectively.

#### **Linked Program Outcomes**

MACH 1. Apply basic safety practices in the machine shop  
 MACH 5. Perform programming, set-up and operation of CNC Machine Tools

#### **Assessment Strategies**

- 4.1. In the classroom, lab, or shop setting
- 4.2. Using computers and actual CNC machine tools
- 4.3. In written and applied assignments
- 4.4. Individually
- 4.5. On tests and quizzes
- 4.6. Given prints, directions, templates, and all available shop equipment and supplies

#### **Criteria**

*Performance will be satisfactory when:*

- 4.1. learner correctly describes the function of M coolant codes
- 4.2. learner correctly describes the function of M subprogram codes
- 4.3. learner uses correct format for codes in program blocks
- 4.4. learner uses correct format for block placement within programs
- 4.5. learner selects appropriate codes when writing CNC machining center programs
- 4.6. learner correctly describes the function of G positioning codes
- 4.7. learner correctly describes the function of G linear and circular interpolation codes
- 4.8. learner correctly describes the function of G machine reference codes
- 4.9. learner correctly describes the function of G cutter compensation codes
- 4.10. learner correctly describes the function of G tool length compensation codes
- 4.11. learner correctly describes the function of G workpiece coordinates codes
- 4.12. learner correctly describes the function of G drilling cycle codes
- 4.13. learner correctly describes the function of M spindle control codes
- 4.14. learner correctly describes the function of M stop and program end codes
- 4.15. learner correctly describes the functions of codes other than G and M codes
- 4.16. learner differentiates codes used for CNC machining centers versus CNC machining centers
- 4.17. learner correctly describes "modal"
- 4.18. learner differentiates modal codes from nonmodal codes
- 4.19. learner applies correct codes to required machine movements when writing programs
- 4.20. assignments are completed by the due date with 80% accuracy
- 4.21. quizzes and tests have accuracy of 80% or higher

### Learning Objectives

- 4.a. Interpret CNC machining center programming codes
- 4.b. Interpret CNC machining center word address codes
- 4.c. Describe program and sequence formats for CNC machining center programming
- 4.d. Determine word address arrangements in blocks
- 4.e. Apply proper programming language format for CNC machining center programs
- 4.f. Select appropriate G, M, and other codes for CNC machining center program blocks
- 4.g. Describe the effect of CNC codes on CNC machining center tool movements

## 5. Apply mathematical concepts to write programs for CNC machine tools

*Domain Cognitive Level Application Status WIP*

### Linked Core Abilities

Apply mathematical concepts.  
Demonstrate ability to think critically.

### Linked Program Outcomes

MACH 2. Interpret industrial/engineering drawings  
MACH 3. Apply precision measuring methods to part inspection  
MACH 5. Perform programming, set-up and operation of CNC Machine Tools

### Assessment Strategies

- 5.1. In the classroom, lab, or shop setting
- 5.2. Using computers and actual machine tools
- 5.3. In written and applied assignments
- 5.4. Individually
- 5.5. On tests and quizzes
- 5.6. Given prints, process sheets, specification sheets, and all available shop equipment and supplies

### Criteria

*Performance will be satisfactory when:*

- 5.1. learner accurately calculates absolute distances from part zero coordinates
- 5.2. learner accurately calculates incremental distances from previous point
- 5.3. learner accurately calculates circular interpolation distances from reference point
- 5.4. learner correctly solves side distances of right triangles
- 5.5. learner correctly solves angle degrees of right triangles
- 5.6. learner seeks assistance for math calculations when needed from instructors
- 5.7. learner correctly calculates cutter compensation for tool radii
- 5.8. learner correctly calculates programming coordinates from part print dimensions
- 5.9. assignments are turned in by due dates with 90% mathematical accuracy
- 5.10. quizzes and tests and tests have 80% mathematical accuracy

### Learning Objectives

- 5.a. Perform addition and subtraction as they relate to CNC machining center coordinates
- 5.b. Compute triangles using trigonometry
- 5.c. Calculate machine moves using absolute values
- 5.d. Calculate machine moves using incremental values
- 5.e. Determine diametrical coordinates based on radial dimensions

## 6. Write multiple function programs for CNC machining centers

*Domain Cognitive Level Application Status WIP*

### Linked Core Abilities

Apply mathematical concepts.  
Demonstrate ability to think critically.  
Use technology effectively.

### Linked Program Outcomes

MACH 2. Interpret industrial/engineering drawings  
MACH 5. Perform programming, set-up and operation of CNC Machine Tools

### **Assessment Strategies**

- 6.1. In the classroom, lab, or shop setting
- 6.2. Using computers and 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, specification sheets, and all available shop equipment and supplies

### **Criteria**

*Performance will be satisfactory when:*

- 6.1. learner writes programs using manual cutter compensation
- 6.2. learner writes programs using G code cutter compensation
- 6.3. learner enters cutter compensation offsets in machine tool per program specifications
- 6.4. learner incorporates at least three tool changes in programs for CNC machining centers
- 6.5. learner incorporates at least three canned cycles in programs for CNC machining centers
- 6.6. learner writes a program that uses at least two subprogram calls
- 6.7. learner writes a program that incorporates cutter compensation, multiple tool changes, and subprograms
- 6.8. learner identifies and corrects program errors
- 6.9. learner proofs multiple function programs in simulator
- 6.10. multiple function programs are ran in CNC machining centers
- 6.11. multiple function programs are accurate enough to run in CNC machining centers
- 6.12. multiple function programs have accuracy of 90% or higher
- 6.13. assignments have accuracy of 90% or higher

### **Learning Objectives**

- 6.a. Write CNC machining center programs using cutter compensation
- 6.b. Write CNC machining center programs with multiple tool changes
- 6.c. Write CNC machining center programs that use canned cycle programs
- 6.d. Write CNC machining center programs that incorporate subprograms

## **7. Prepare CNC Mills and Lathes to run programs**

*Domain Psychomotor Status WIP*

### **Linked Core Abilities**

Demonstrate ability to think critically.  
Use effective communication skills.  
Use technology effectively.

### **Linked Program Outcomes**

MACH 2. Interpret industrial/engineering drawings  
MACH 3. Apply precision measuring methods to part inspection  
MACH 5. Perform programming, set-up and operation of CNC Machine Tools

### **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, diagrams, materials, and all available shop equipment and supplies

### **Criteria**

*Performance will be satisfactory when:*

- 7.1. learner participates in class discussion regarding job planning
- 7.2. learner completes a job process plan
- 7.3. learner writes CNC machining center programs using approved programming sequences
- 7.4. learner runs warm up program for CNC machining center
- 7.5. learner runs warm up program with a tool in the spindle
- 7.6. learner runs warm up program with coolant flowing
- 7.7. learner correctly secures work in CNC machining center

- 7.8. learner correctly uses edgefinder to locate workpiece edges
- 7.9. learner correctly enters workpiece offsets in machine tool control
- 7.10. learner correctly loads tools in carousel or magazine
- 7.11. learner correctly sets tool length offsets
- 7.12. learner enters offsets correctly in machine tool control
- 7.13. learner recognizes hazards of sharp tools in the carousel when setting up work or tools
- 7.14. learner loads programs in the machine tool control using at least two different methods
- 7.15. learner does not damage tools or work when setting tool and work offsets
- 7.16. learner does not damage tool presetter when setting tools
- 7.17. learner does not damage edgefinder when locating work edges
- 7.18. learner seeks assistance from instructor when unsure of procedures or program
- 7.19. procedures meet each rubric criterion with 85% proficiency

### Learning Objectives

- 7.a. Discuss CNC machining center job planning and programming sequence
- 7.b. Explain the importance of warm-up cycles for CNC machining centers
- 7.c. Demonstrate proper work set up procedures for CNC machining centers
- 7.d. Demonstrate proper tool set up procedures for CNC machining centers
- 7.e. Locate work coordinates and set offsets
- 7.f. Set tool length offsets
- 7.g. Load programs in CNC machine tools

## 8. Prove CNC Mills and Lathes program validity

*Domain Cognitive Status WIP*

### Linked Core Abilities

Demonstrate ability to think critically.  
Use technology effectively.

### Linked Program Outcomes

MACH 1. Apply basic safety practices in the machine shop  
MACH 3. Apply precision measuring methods to part inspection  
MACH 5. Perform programming, set-up and operation of CNC Machine Tools

### Assessment Strategies

- 8.1. In the lab or shop setting
- 8.2. In written and applied assignments
- 8.3. Using actual CNC turning centers
- 8.4. Individually
- 8.5. On tests and quizzes
- 8.6. Given prints, diagrams, materials, and all available shop equipment and supplies

### Criteria

*Performance will be satisfactory when:*

- 8.1. learner locates the correct CNC milling program
- 8.2. learner correctly activates program to run
- 8.3. learner runs program in graphical interface or simulator
- 8.4. learner verifies accuracy of CNC machining center program
- 8.5. learner correctly identifies problems with program
- 8.6. learner corrects program errors
- 8.7. learner re-proofs program in simulator to verify errors have been corrected
- 8.8. learner saves program as text file in specified location
- 8.9. learner uses at least two of the specified storage mediums to save programs
- 8.10. learner sends programs to instructor as e-mail attachments
- 8.11. learner runs programs to cut part or design that was specified
- 8.12. learner inspects part before removing from the machine
- 8.13. programs have 90% accuracy prior to running in CNC machining center
- 8.14. projects or parts are produced per print specification projects or parts meet 70% of specified criteria
- 8.15. lab exams meet a minimum of 70% of specified criteria

### Learning Objectives

- 8.a. Call up and activate programs



- 8.b. Verify programs in graphical interface
- 8.c. Correct program errors
- 8.d. Inspect part accuracy

**9. Describe terminology associated with CNC turning center programming**

*Domain Cognitive Level Comprehension Status WIP*

**Linked Core Abilities**

Apply mathematical concepts.  
 Demonstrate ability to think critically.  
 Use effective communication skills.

**Linked Program Outcomes**

MACH 1. Apply basic safety practices in the machine shop  
 MACH 5. Perform programming, set-up and operation of CNC Machine Tools

**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, materials, and all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*

- 9.1. learner participates in classroom discussion on terminology related to CNC machining
- 9.2. learner scores 70% or greater on terminology quiz
- 9.3. learner uses the correct terms for CNC turning center system components
- 9.4. learner correctly identifies print symbols as they relate to CNC machining
- 9.5. learner correctly describes the function of CNC general preparatory codes for turning centers
- 9.6. learner correctly describes the function of miscellaneous CNC codes for turning centers
- 9.7. learner interprets prints to write CNC turning programs
- 9.8. learner selects appropriate tools for CNC turning machine processes
- 9.9. learner describes CNC turning machine codes other than G and M codes
- 9.10. assignments have accuracy of 70% or higher

**Learning Objectives**

- 9.a. Identify terms related to CNC turning machines
- 9.b. Describe CNC turning program word address terms
- 9.c. Explain G and M code terms related to CNC turning center programming
- 9.d. Identify print terms related to CNC machining
- 9.e. Differentiate tooling terms as they relate to CNC turning centers

**10. Write multiple function programs for CNC turning centers**

*Domain Cognitive Level Application Status WIP*

**Linked Core Abilities**

Demonstrate ability to think critically.  
 Use technology effectively.

**Linked Program Outcomes**

MACH 2. Interpret industrial/engineering drawings  
 MACH 5. Perform programming, set-up and operation of CNC Machine Tools

**Assessment Strategies**

- 10.1. In the classroom, lab, or shop setting
- 10.2. Using computers and actual CNC machine tools
- 10.3. In written and applied assignments
- 10.4. Individually
- 10.5. On tests and quizzes

10.6. Given prints, process sheets, specification sheets, and all available shop equipment and supplies

**Criteria**

*Performance will be satisfactory when:*

- 10.1. learner writes programs using tool nose radius compensation
- 10.2. learner writes programs using G code cutter compensation
- 10.3. learner enters cutter compensation offsets in machine tool per program specifications
- 10.4. learner incorporates at least three tool changes in programs for CNC turning centers
- 10.5. learner incorporates at least two canned cycles in programs for CNC turning centers
- 10.6. learner uses G70 and G71 machine cycles in CNC turning center programs
- 10.7. learner proofs multiple function programs in graphical simulation
- 10.8. learner identifies and corrects program errors
- 10.9. multiple function programs are accurate enough to run in CNC turning centers
- 10.10. multiple function programs are ran in CNC turning centers
- 10.11. multiple function programs have accuracy of 90% or higher
- 10.12. assignments have accuracy of 80% or higher

**Learning Objectives**

- 10.a. Write CNC turning center programs with multiple tool changes
- 10.b. Write CNC turning center programs using tool nose radius compensation
- 10.c. Write CNC turning center programs that include canned cycles
- 10.d. Write CNC turning center programs that include G71 and G70 machine cycles