

Western Technical College

## 31444305 Programming/CAM for CNC Milling

### Course Outcome Summary

#### Course Information

<b>Description</b>	This course will include instruction and practice in writing programs for CNC milling machines. Instruction will begin with manually writing G&M code programs and advance to creating programs with CAM software.
<b>Career Cluster</b>	Manufacturing
<b>Instructional Level</b>	One-Year Technical Diploma
<b>Total Credits</b>	2
<b>Total Hours</b>	72

#### Textbooks

*Mastercam X8 Training Guide – Mill 2D*. Copyright 2014. Manton, Matthew and Duane Weidinger. Publisher: Cominstructor.com. **ISBN-13:** 978-1-927359-48-8. Required.

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

#### Learner Supplies

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

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

#### Course Competencies

1. **Associate the Cartesian coordinate system with CNC machining center axes.**

##### Assessment Strategies

- 1.1. Applied assignments
- 1.2. Tests & quizzes

1.3. Project

**Criteria**

*You will know you are successful when*

- 1.1. you select correct CNC milling machine axis when plotting coordinates.
- 1.2. you use prints to plot coordinate points for CNC machining centers.
- 1.3. you incorporate the three Z positions appropriately into programs.
- 1.4. you select the correct relationship to part zero reference for X and Y coordinates in programs.

**Learning Objectives**

- 1.a. Discuss the purpose of the Cartesian coordinate system in CNC machining center machining.
- 1.b. Identify coordinate axes of CNC mills and machining centers.
- 1.c. Describe the three Z position relationships between the workpiece and tool.
- 1.d. Explain the X and Y coordinate relationships to the part zero reference location.
- 1.e. Locate coordinate points graphically for CNC machining center axes.

**2. Apply terminology associated with CNC machining center programming.**

**Assessment Strategies**

- 2.1. Applied assignments
- 2.2. Tests & quizzes
- 2.3. Project

**Criteria**

*You will know you are successful when*

- 2.1. you participate in classroom discussion on terminology related to CNC machining.
- 2.2. you score 70% or greater on terminology quiz.
- 2.3. you use the correct terms for CNC machining center system components.
- 2.4. you correctly identify print symbols as they relate to CNC machining.
- 2.5. you correctly describe the function of CNC general preparatory codes for machining centers.
- 2.6. you correctly describe the function of miscellaneous CNC codes for machining centers.
- 2.7. you interpret prints to write CNC machining center programs.
- 2.8. you select appropriate tools for CNC milling machine processes.
- 2.9. you complete assignments with an accuracy of 70% or higher.
- 2.10. you describe CNC machining center codes other than G and M codes.

**Learning Objectives**

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

**3. Classify tooling for CNC machining centers.**

**Assessment Strategies**

- 3.1. Applied assignments
- 3.2. Tests & quizzes
- 3.3. Project

**Criteria**

*You will know you are successful when*

- 3.1. you correctly identify the types of face and end mills used in CNC milling machines.
- 3.2. you correctly identify the types of hole cutting tools used in milling operations.
- 3.3. you correctly identify tools used inside holes in milling operations.
- 3.4. you accurately recognize tool wear.
- 3.5. you differentiate types of materials used for cutting tools.
- 3.6. you correctly describe the purpose of various materials used for cutting tools.
- 3.7. you calculate correct speeds and feeds for various tool materials and workpiece material.
- 3.8. you explain the benefits and disadvantages of climb and conventional machining as they relate to CNC milling machines.

- 3.9. you correctly describe the types of cutting fluids used in CNC operations.
- 3.10. you explain how cutting fluids are selected for CNC milling operations.
- 3.11. you determine correct spindle rotation based on tooling.
- 3.12. you complete assignments on time and have accuracy of 70% or better.
- 3.13. you complete quizzes and tests with an accuracy of 70% or better.

**Learning Objectives**

- 3.a. Identify CNC milling machine tooling.
- 3.b. Select appropriate tools for hole operations.
- 3.c. Select appropriate tools for milling operations.
- 3.d. Describe types of materials used for cutting tools.
- 3.e. Calculate speeds and feeds for CNC milling applications.
- 3.f. Explain the purpose of cutting fluids in CNC milling applications.

**4. Write basic programs with G and M codes for CNC mills or machining centers.**

**Assessment Strategies**

- 4.1. Applied assignments
- 4.2. Tests & quizzes
- 4.3. Project

**Criteria**

*You will know you are successful when*

- 4.1. you correctly describe the three basic sections of a CNC machining center program.
- 4.2. you develop a start sequence format based on class lessons.
- 4.3. you use start sequence correctly in all programs written.
- 4.4. you develop an ending sequence format based on class lessons.
- 4.5. you use ending sequence in all programs written.
- 4.6. you write absolute positioning linear interpolation program from part print.
- 4.7. you write linear interpolation name program using absolute positioning.
- 4.8. you write absolute positioning circular interpolation program from part print.
- 4.9. you write circular interpolation name program using absolute positioning.
- 4.10. you incorporate Z position moves in programs.
- 4.11. you use rapid moves for Zc movements in programs.
- 4.12. you find and correct errors in programs.
- 4.13. you develop programs proofed to run in CNC machining centers without errors.
- 4.14. you develop programs accurate enough to run in CNC machining centers.

**Learning Objectives**

- 4.a. Incorporate G and M code in programs.
- 4.b. Write program start sequences for CNC machining centers.
- 4.c. Write linear interpolation programs for CNC machining centers.
- 4.d. Write circular interpolation programs for CNC machining centers.
- 4.e. Write a program ending sequence for CNC machining centers.
- 4.f. Write absolute positioning programs for CNC machining centers.
- 4.g. Write incremental positioning programs for CNC machining centers.
- 4.h. Explain the parts of a CNC machining center program.

**5. Create a working program using CAM software.**

**Assessment Strategies**

- 5.1. Applied assignments
- 5.2. Tests & quizzes
- 5.3. Project

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

**Assessment Strategies**

- 6.1. Applied assignments
- 6.2. Tests & quizzes
- 6.3. Project

**Criteria**

*You will know you are successful when*

- 6.1. you write programs using manual cutter compensation.
- 6.2. you write programs using G code cutter compensation.
- 6.3. you enter cutter compensation offsets in machine tool per program specifications.
- 6.4. you incorporate at least three tool changes in programs for CNC machining centers.
- 6.5. you incorporate at least three canned cycles in programs for CNC machining centers.
- 6.6. you write a program that uses at least two subprogram calls.
- 6.7. you write a program the incorporates cutter compensation, multiple tool changes, and subprograms.
- 6.8. you identify and correct program errors.
- 6.9. you proof multiple-function programs in simulator.
- 6.10. multiple function programs are run in CNC machining centers.
- 6.11. multiple function programs are accurate enough to run in CNC machining centers.
- 6.12. multiple function programs have an accuracy of 90% or higher.
- 6.13. your assignments have an 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.