

**Western Technical College**

**31444301 CNC Production Mill - Operation**

**Course Outcome Summary**

**Course Information**

<b>Description</b>	Operation of CNC (Computer Numerical Control) machining centers includes calling up programs, loading and unloading parts, inspection, and the recognition of tool wear. Procedural processes, inspection of parts, and the use of inspection sheets and guides will be covered.
<b>Career Cluster</b>	Manufacturing
<b>Instructional Level</b>	Technical Diploma Courses
<b>Total Credits</b>	1
<b>Total Hours</b>	36

**Textbooks**

No textbook 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.

**Success Abilities**

1. Apply mathematical concepts.
2. Demonstrate ability to think critically.
3. Demonstrate ability to value self and work ethically with others in a diverse population.
4. Make decisions that incorporate the importance of sustainability.
5. Use effective communication skills.
6. Use technology effectively.

**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. Identify various types of CNC machining centers.

#### Assessment Strategies

- 1.1. In the classroom, lab, or shop setting
- 1.2. Written and applied assignments (score 70% or higher)
- 1.3. Exams / Quizzes (score 70% or higher)
- 1.4. Given diagrams, materials, and all available shop equipment and supplies

#### Criteria

*You will know you are successful when*

- 1.1. you list the common brands of CNC machining centers.
- 1.2. you match brands to control models.
- 1.3. you identify brands and controllers in the shop or lab.
- 1.4. you participate in lab or shop orientation for machining centers.
- 1.5. you participate in lab or shop discussion of CNC machining center features.
- 1.6. you complete MasterTask CNC Mills Module 1 interactive test.

#### Learning Objectives

- 1.a. Identify CNC machining center brands.
- 1.b. Describe control models within machine brands.
- 1.c. Explain differences in CNC machining center features for various models.
- 1.d. Identify CNC machining center workpiece holding and loading mechanisms.
- 1.e. Identify CNC machining center tool handling and retrieval mechanisms on CNC machining centers.

### 2. Describe the coordinate movements of CNC machining centers.

#### Assessment Strategies

- 2.1. In the classroom, lab, or shop setting
- 2.2. written and applied assignments (score 70% or higher)
- 2.3. Tests / Quizzes (score 70% or higher)
- 2.4. Given diagrams, models, materials, and all available shop equipment and supplies

#### Criteria

*You will know you are successful when*

- 2.1. you complete a diagram showing CNC machining center axis coordinate movements.
- 2.2. you demonstrate relevant axes movements on machine axes model.
- 2.3. you identify PRZ and machine home locations on a part diagram or print.
- 2.4. you demonstrate tool movement relative to coordinate system using models.
- 2.5. you diagram part reference zero and machine home locations.
- 2.6. you complete MasterTask CNC Mills Module 2 interactive test.
- 2.7. you complete MasterTask CNC Mills Module 3 interactive test.
- 2.8. you complete MasterTask CNC Mills Module 4 interactive test.
- 2.9. you complete MasterTask CNC Mills Module 5 interactive test.

#### Learning Objectives

- 2.a. Describe safety procedures for CNC machining centers.
- 2.b. Describe basic operating principles of CNC machining centers.
- 2.c. Describe CNC machining center workpiece holding and loading mechanisms.
- 2.d. Describe automatic tool handling and retrieval mechanisms on CNC machining centers.
- 2.e. Describe CNC machining center axis movements relative to the Cartesian coordinate system.
- 2.f. Determine position of signed numbers on a coordinate grid system.
- 2.g. Describe the A, B, and C axes movements of a CNC machining center relative to the coordinate system.
- 2.h. Describe the machine zero or home location on the CNC machining center.
- 2.i. Describe the part zero reference location on the CNC machining center.
- 2.j. Differentiate PRZ and Machine Zero.

- 2.k. Describe a typical application of PRZ relative to machine zero.
- 2.l. Explain tool movement control relative to the coordinate system.
- 2.m. Describe the tool change position relative to Home and PRZ.

### **3. Identify common CNC machining center programming methods.**

#### **Assessment Strategies**

- 3.1. In the classroom, lab, or shop setting
- 3.2. Written and applied assignments (score 70% or higher)
- 3.3. Test / Quizzes (score 70% or higher)
- 3.4. Given prints, diagrams, materials, and all available shop equipment and supplies

#### **Criteria**

*You will know you are successful when*

- 3.1. you identify types of controls on specific CNC milling machines in the machine tool lab or shop.
- 3.2. you describe the differences in programming requirements for specific CNC milling machines in the machine tool lab or shop.
- 3.3. you identify basic EIA/ISO codes on CNC machining center display screen.
- 3.4. you select tools for CNC milling machines for given applications.
- 3.5. you complete MasterTask CNC Mills Module 7 interactive test.

#### **Learning Objectives**

- 3.a. Identify various CNC machining center models of controls.
- 3.b. Identify common languages used in CNC mill programming.
- 3.c. Differentiate conversational controls and EIA controls on CNC machining centers.
- 3.d. Describe various machining operations performed in CNC machining centers.
- 3.e. Identify tools for various machining operations performed in CNC machining centers.
- 3.f. Identify universal basic function EIA programming codes.
- 3.g. Identify the universally common elements of a conversational program.
- 3.h. Describe the difference between online and offline programming.

### **4. Operate controls on CNC machining centers.**

#### **Assessment Strategies**

- 4.1. In the classroom, lab, or shop setting
- 4.2. Written and applied assignments (score 70% or higher)
- 4.3. Test / Quizzes (score 70% or higher)
- 4.4. Given prints, diagrams, materials, and all available shop equipment and supplies

#### **Criteria**

*You will know you are successful when*

- 4.1. you locate and identify the main controls on CNC milling machines in the lab or shop.
- 4.2. you locate and identify CNC control components on CNC milling machines in the machine tool lab or shop.
- 4.3. you sequentially list the steps required to turn on each type of CNC milling machine in the machine tool lab or shop.
- 4.4. you turn on each type of CNC milling machine in the machine tool lab or shop.
- 4.5. you navigate between menus, chapters, and pages on each type of CNC machining center control in the machine tool lab or shop.
- 4.6. you use cursors and control buttons on CNC control monitors in the machine tool lab or shop.
- 4.7. you use manual jog controls on each type of CNC milling machine in the machine tool lab or shop.
- 4.8. you describe the purpose of each machine control button and the emergency stop.
- 4.9. you describe typical information found on each page of the CNC machining center monitor.
- 4.10. you complete MasterTask CNC Mills Module 9 interactive test.
- 4.11. you complete MasterTask CNC Mills Module 10 interactive test.
- 4.12. you complete MasterTask CNC Mills Module 27 interactive test.

#### **Learning Objectives**

- 4.a. Identify main controls on various CNC machining centers.
- 4.b. Identify the basic CNC control components on various machines.
- 4.c. Explain the function of each of the components on a CNC machining center control.
- 4.d. List the steps required to turn on CNC machining centers.

- 4.e. Demonstrate the procedure to turn on and home CNC machines.
- 4.f. Identify mode selection controls.
- 4.g. Describe the function of each of the modes.
- 4.h. Discuss typical variations found on different brands and types of CNC machining centers.
- 4.i. Demonstrate the navigation of menus, chapters, and pages on CNC control monitors.
- 4.j. Demonstrate the navigation between position, program, and offset pages on CNC control monitors.
- 4.k. Describe the information found on each page of the CNC control monitor.
- 4.l. Demonstrate the use of cursors and control buttons on CNC control monitors.
- 4.m. Explain the use of the Emergency Stop button on CNC machining centers.
- 4.n. Describe the variations between Handle Jog controls on various machines.
- 4.o. Demonstrate the use of Handle Jog controls on various machines.

## 5. Call up programs on CNC machining centers.

### Assessment Strategies

- 5.1. In the classroom, lab, or shop setting
- 5.2. Written and applied assignments (score 70% or higher)
- 5.3. Test / Quizzes (score 70% or higher)
- 5.4. Given prints, diagrams, materials, and all available shop equipment and supplies

### Criteria

*You will know you are successful when*

- 5.1. you sequentially list the steps for calling up programs on various types of CNC milling machines.
- 5.2. you identify the buttons and modes for calling up programs on various CNC milling machines in the machine tool lab or shop.
- 5.3. you sequentially list the steps required for showing graphical plotting of programs.
- 5.4. you call up programs in conversational control CNC milling machines.
- 5.5. you call up programs in EIA/ISO controlled CNC machining centers.
- 5.6. you verify programs in the graphical interface of conversational controlled CNC milling machines.
- 5.7. you verify programs in EIA/ISO controlled CNC machining centers.
- 5.8. you complete MasterTask CNC Mills Module 76 interactive test.

### Learning Objectives

- 5.a. List the steps for calling up programs on various CNC machining centers.
- 5.b. Identify the buttons on the CNC machine control for calling up programs.
- 5.c. Demonstrate the procedure for calling up programs on CNC machining centers.
- 5.d. Call up programs on conversational and EIA controlled CNC machining centers.
- 5.e. Verify programs in graphical interface.

## 6. Perform scheduled machine maintenance.

### Assessment Strategies

- 6.1. In the classroom, lab, or shop setting
- 6.2. Written and applied assignments (score 70% or higher)
- 6.3. Tests / Quizzes (score 70% or higher)
- 6.4. Given diagrams, logs, materials, and all available shop equipment and supplies

### Criteria

*You will know you are successful when*

- 6.1. you locate coolant tanks on all CNC milling machines in the machine tool lab or shop.
- 6.2. you state the correct mixture and concentration for coolant tank fluid.
- 6.3. you identify situations when the coolant tank needs to be filled.
- 6.4. you fill the coolant tank.
- 6.5. you locate and identify oil system components on all CNC milling machines in the machine tool lab or shop.
- 6.6. you demonstrate the process for fluid level maintenance after machine warm up.
- 6.7. you maintain a maintenance log.
- 6.8. you complete MasterTask CNC Mills Module 27 interactive test.

### Learning Objectives

- 6.a. Identify coolant tank locations.
- 6.b. List the components of CNC machining center coolant systems.

- 6.c. Describe how coolant and chips are removed from the machining area of a CNC machining center.
- 6.d. Describe procedures for coolant tank inspection.
- 6.e. Describe the process for filling coolant tanks.
- 6.f. Describe the components of the hydraulic system.
- 6.g. Describe the procedures for inspecting hydraulic systems.
- 6.h. Describe the lubrication system components and maintenance procedures.
- 6.i. Describe the process for maintaining fluid levels after machine warm up.
- 6.j. Discuss the use of lock-out procedures during maintenance.
- 6.k. Explain the procedures for checking and correcting system deficiencies.
- 6.l. Explain the function of automatic maintenance check systems.
- 6.m. Perform system checks and maintenance.

## 7. Set up tools in CNC machining centers.

### Assessment Strategies

- 7.1. In the classroom, lab, or shop setting
- 7.2. Written and applied assignments (score 70% or higher)
- 7.3. Tests / Quizzes (score 70% or higher)
- 7.4. Given prints, specification sheets, and all available shop equipment and supplies

### Criteria

*You will know you are successful when*

- 7.1. you use safe operating procedures when setting up and changing tools on CNC milling machines.
- 7.2. you identify and select tools for CNC milling machines from tool list specifications.
- 7.3. you use CNC machining center controls to rotate carousel.
- 7.4. you control the direction of carousel rotation.
- 7.5. you change tools in CNC milling machines with manual tool changers.
- 7.6. you change and load tools in CNC machining centers with automatic tool changers.
- 7.7. you complete MasterTask CNC Mills Module 7 interactive test.
- 7.8. you complete MasterTask CNC Mills Module 8 interactive test.
- 7.9. you complete MasterTask CNC Mills Module 40 interactive test.
- 7.10. you complete MasterTask CNC Mills Module 47 interactive test.
- 7.11. you complete MasterTask CNC Mills Module 48 interactive test.

### Learning Objectives

- 7.a. Identify the various types of cutters, tools and tool holders for CNC machining centers.
- 7.b. Select tools and holders for CNC machining centers.
- 7.c. Demonstrate the procedure for changing tools in CNC machining centers without tool carousels.
- 7.d. Identify control buttons to move or index the tool carousel.
- 7.e. Describe the safe location for changing tools.
- 7.f. Demonstrate rotating the carousel to index tool positions
- 7.g. Demonstrate the procedure for changing tools in CNC machining centers.
- 7.h. Interpret a tool drawing to determine axis direction relative to spindle centerline.
- 7.i. Demonstrate the procedures for establishing and setting tool length offsets.

## 8. Set up work in CNC machining centers.

### Assessment Strategies

- 8.1. In the classroom, lab, or shop setting
- 8.2. Written and applied assignments (score 70% or higher)
- 8.3. Tests / Quizzes (score 70% or higher)
- 8.4. Given prints, stock, and all available shop equipment and supplies

### Criteria

*You will know you are successful when*

- 8.1. you start up and home CNC milling machines in the machine tool lab or shop.
- 8.2. you recognize overtravel alarms within time period specified and participate in discussion to solve the problem.
- 8.3. you apply safety procedures 100% of the time while setting up work in CNC milling machines.
- 8.4. you set up and secure work in conversationally controlled CNC milling machines.
- 8.5. you set up and secure work in automatic CNC machining centers.

- 8.6. you use stock stops for production machining.
- 8.7. you set up work in fixtures.
- 8.8. you complete MasterTask CNC Mills Module 11 interactive test.
- 8.9. you complete MasterTask CNC Mills Module 51 interactive test.

#### **Learning Objectives**

- 8.a. Describe the procedures for homing various CNC machining centers.
- 8.b. Demonstrate the procedures for homing various CNC machining centers.
- 8.c. Describe the conditions that cause an overtravel alarm.
- 8.d. Demonstrate the process of securing work in CNC machining centers.
- 8.e. Demonstrate the procedures for using stock stops for production machining.
- 8.f. Demonstrate the procedures for establishing and setting work coordinates.

### **9. Run programs in CNC machining centers.**

#### **Assessment Strategies**

- 9.1. In the classroom, lab, or shop setting
- 9.2. Written and applied assignments (score 70% or higher)
- 9.3. Tests / Quizzes (score 70% or higher)
- 9.4. Given prints, diagrams, stock, and all available shop equipment and supplies

#### **Criteria**

*You will know you are successful when*

- 9.1. you apply safety procedures 100% of the time while running CNC milling machines.
- 9.2. you create an accurate checklist for the steps required to setup and perform a production run in CNC milling machines.
- 9.3. you call up programs in each type of CNC milling machine in the machine tool lab or shop.
- 9.4. you follow standard procedures for setting up work and tools in the CNC milling machines.
- 9.5. you locate offset screens in each type of CNC milling machine in the machine tool lab or shop.
- 9.6. you set tool to Z top of part.
- 9.7. you set tool X and Y locations for parts.
- 9.8. you locate button on machine control to run programs.
- 9.9. you start and run programs.
- 9.10. you check and remove parts from the CNC milling machines after program has run.
- 9.11. you follow production steps to continue a production part run
- 9.12. you complete MasterTask CNC Mills Module 77 interactive test.

#### **Learning Objectives**

- 9.a. Practice safe operating procedures for running CNC machining centers.
- 9.b. List the procedures for setting up and performing a production run on CNC machining centers.
- 9.c. Call up programs that will be run in CNC machining centers.
- 9.d. Follow procedures for securing work in CNC machining centers.
- 9.e. Demonstrate how to locate offset screens using various machine controls.
- 9.f. Set tool length and diameter offsets.
- 9.g. Set work coordinate offsets.
- 9.h. Explain the importance of using coolant in cutting operations on the CNC machining center.
- 9.i. Run programs in various CNC machining centers.
- 9.j. Perform production steps required after first part is run.

### **10. Perform quality inspections on CNC milled parts.**

#### **Assessment Strategies**

- 10.1. In the classroom, lab, or shop setting
- 10.2. Written and applied assignments (score 70% or higher)
- 10.3. Tests / Quizzes (score 70% or higher)
- 10.4. Given prints, diagrams, pictures, inspection sheets, materials, and all available shop equipment and supplies

#### **Criteria**

*You will know you are successful when*

- 10.1. you apply safety procedures 100% of the time while inspecting parts in CNC milling machines.
- 10.2. you identify part dimensions to measure and inspect based on specifications on documents.

- 10.3. you identify part finishes to inspect based on specifications on documents.
- 10.4. you identify the frequency with which to inspect parts.
- 10.5. you perform inspections on parts.
- 10.6. you follow directions for inspection frequency.
- 10.7. you record inspection results on documentation sheets.
- 10.8. you identify problems with part quality.
- 10.9. you follow the correct procedures for reporting part quality problems.
- 10.10. you complete MasterTask CNC Mills Module 37 interactive test.

**Learning Objectives**

- 10.a. Analyze part prints or specification to determine part dimensions to inspect.
- 10.b. Demonstrate safe procedures for inspecting parts while still in the CNC machining centers.
- 10.c. Perform inspections on parts after machining per specified frequency.
- 10.d. Explain the concepts of locational, roughness, and size tolerances.
- 10.e. Identify quality defects in machined parts.
- 10.f. Record inspection results.
- 10.g. Explain the procedure for reporting problems with part quality.

**11. Recognize problems related to CNC machine operation.**

**Assessment Strategies**

- 11.1. In the classroom, lab, or shop setting
- 11.2. Written and applied assignments (score 70% or higher)
- 11.3. Tests / Quizzes (score 70% or higher)
- 11.4. Given diagrams, materials, and all available shop equipment and supplies

**Criteria**

*You will know you are successful when*

- 11.1. you apply safety procedures 100% of the time while running CNC milling machines.
- 11.2. you list the processes required for efficiently finding and eliminating quality problems.
- 11.3. you follow flow chart to isolate potential problem sources.
- 11.4. you identify problems with part quality.
- 11.5. you identify problems with part quality as a result of chatter.
- 11.6. you identify machine vibration sounds.
- 11.7. you use of override controls to reduce or correct vibration problems.
- 11.8. you identify finish problems associated with tool wear, tool failure, or workholding problems.
- 11.9. you list potential causes of broken cutter inserts and suggests preventative actions.
- 11.10. you participate in discussion of operator responsibilities.
- 11.11. you follow specified procedures for reporting problems during machining.
- 11.12. you complete MasterTask CNC Mills Module 38 interactive test.
- 11.13. you complete MasterTask CNC Mills Module 39 interactive test.

**Learning Objectives**

- 11.a. Define the machine operator's role in identifying quality defects.
- 11.b. Identify chatter sounds between the workpiece and tool.
- 11.c. Identify the condition that chatter creates on the workpiece surface.
- 11.d. Follow a logical path through likely problem sources to isolate areas to investigate.
- 11.e. Describe potential problem sources related to quality problems.
- 11.f. Describe the steps required to correct problems by making an adjustment and resuming production.
- 11.g. Explain common causes of chatter.
- 11.h. Explain ways to correct vibration using overrides.
- 11.i. Associate chatter sources with part or tool conditions.
- 11.j. Identify causes of finish problems other than from vibration.
- 11.k. Explain the relationship between tool war and rough or finish operations.
- 11.l. Describe the operator's responsibility after discovering machining problems.

**12. Change CNC machining center tools and inserts.**

**Assessment Strategies**

- 12.1. In the classroom, lab, or shop setting
- 12.2. Written and applied assignments (score 70% or higher)
- 12.3. Tests / Quizzes (score 70% or higher)

12.4. Given diagrams, materials, and all available shop equipment and supplies

**Criteria**

*You will know you are successful when*

- 12.1. you identify inserts that are damaged or worn and need to be changed.
- 12.2. you identify cutting tools that are damaged or worn and must be replaced.
- 12.3. you select the correct insert shape and style for replacement.
- 12.4. you change inserts.
- 12.5. you select the correct cutting tool for replacement.
- 12.6. you change cutting tools.
- 12.7. you complete documentation stating the insert or tool that was changed and the likely cause of the damage.
- 12.8. you adjust offsets in the CNC milling machine control.
- 12.9. you notify specified supervisor or setup person after changing inserts or tools.
- 12.10. you complete MasterTask CNC Mills Module 41 interactive test.

**Learning Objectives**

- 12.a. Explain the procedure for changing tools and inserts in the CNC machining centers.
- 12.b. Perform inspections of tooling and inserts.
- 12.c. Identify the effect of damaged or worn inserts on workpiece finish.
- 12.d. Identify damaged or worn inserts.
- 12.e. Explain the most likely causes of insert failure.
- 12.f. Demonstrate the process of changing inserts.
- 12.g. Adjust offsets as needed.
- 12.h. Explain operator responsibility after changing inserts.