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# Autodesk Certified Expert in CAM for Multi-Axis Milling

Exam objectives

## Target audience

The Autodesk Certified Expert (ACE) certification is a true differentiator for candidates looking to get ahead in their career. Candidates who hold this certification possess not only expert-level knowledge and skill, they're also leaders in their industries and pioneer innovation in their organizations. Preparing to become an Autodesk Certified Expert typically comes from a progressive development of skills and knowledge of emerging toolsets, equivalent to approximately 400 hours (minimum) to 1,200 hours (recommended) of software experience.

Candidates who obtain this certification will have demonstrated expert-level skills in computer-aided Manufacturing (CAM) for multi-axis milling using Fusion 360. The certification exam will also validate a candidate's abilities in process planning, toolpath creation for complex three-dimensional parts, and output for multi-axis machining. These skills are in demand across a wide range of engineering and design industries, including aeronautical, aerospace, defense, automotive, mechanical, industrial design, manufacturing, medical, and energy.

**Prerequisite skills**

It's expected that candidates will already know how to:

- Navigate the user interface.
- Identify areas of the browser.
- Transition through various environments.
- Know the available file types.
- Display a part or assembly.
- Create fully constrained sketches.
- Use features such as extrude, hole, and patch.
- Identify various planes and axes.
- Identify workholding devices for multi-axis computer numerical control (CNC) milling.
- Create a distributed design.

- Fully constrain assembly parts.
- Create a process plan for multi-axis milling.
- Create a CAM setup for CNC milling.
- Create and manage a tool library.
- Create 3-axis toolpaths for roughing and finishing.
- Create 3+1 and 3+2-axis toolpaths for roughing and finishing.
- Create simultaneous 5-axis toolpaths for finishing.
- Explain multi-axis tool control strategies.
- Create a numerical control (NC) program to output specific toolpaths.
- Create probing operations for inspection.
- Create manual NC code.
- Create a setup sheet.
- Export NC code for a single setup.

## Exam objectives

Here are some topics and software features that may be covered in the exam.

1. **Plan and setup work**
   - **1.1. Interpret supplied drawing to select and plan orders of operation based on multi-axis availability**
   - **1.2. Apply procedural concepts required to perform stock prep for multi-axis fixturing**
   - **1.3. Determine how to design fixturing method, ensure collision avoidance, and evaluate cutting forces for multi-axis processes**
     - 1.3.a. Review design geometry and determine appropriate fixturing method
     - 1.3.b. Review design geometry and determine order of operations
   - **1.4. Apply procedural concepts required to use multi-axis capabilities to optimize operations**
     - 1.4.a. Review design geometry and determine if a multi-axis machine is a good choice
   - **1.5. Perform CAM setup with Fusion 360 for multi-axis fixturing**
     - 1.5.a. Determine Work Coordinate System (WCS) location for multi-axis positioning
     - 1.5.b. Determine WCS location for multi-axis machines based on center of rotation
     - 1.5.c. Set up a machine configuration for multi-axis machines

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## 2. Machine setup

### 2.1. Plan and assemble tools and holders digitally to ensure agreement between physical tool and digital representation

2.1.a. Determine appropriate tool and holder for specific geometry or specifications

### 2.2. Plan and assemble workholding digitally to ensure agreement between physical and digital representation

2.2.a. Determine appropriate workholding required based on specifications or geometry

### 2.3. Establish work offsets and operation parameters for multi-axis machines

2.3.a. Determine appropriate strategy for WCS positioning for multiple-fixture machining

## 3. Program toolpaths

### 3.1. Select the appropriate machining strategy

3.1.a. Select the appropriate toolpath based on geometry

### 3.2. Define tool orientation for multi-axis positioning

3.2.a. Determine axis of rotation for a 3+1 and 3+2 toolpaths

3.2.b. Understand tool axis control for wrapped 2D toolpaths

### 3.3. Determine toolpath containment geometry and approach

3.3.a. Define toolpath containment by selection of edges, sketches, or surfaces

3.3.b. Define toolpath slope limits

### 3.4. Define tool orientation for simultaneous multi-axis machining

3.4.a. Determine tool tilt angles for optimal tool contact

### 3.5. Determine collision avoidance strategy

3.5.a. Understand Shaft and Holder options

3.5.b. Use Collisions Avoidance in a Steep and Shallow toolpath

3.5.c. Apply toolpath trimming

3.5.d. Adjust toolpath retraction policy to limit rapid movements

### 3.6. Determine strategies to optimize individual multi-axis machining toolpaths

3.6.a. Determine program order of operation changes for efficiency or precision

3.6.b. Apply multi-axis swarf toolpath options

3.6.c. Apply smoothing options in a Steep and Shallow toolpath

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4. Verify and simulate
   - **4.1. Apply concepts required to perform toolpath and machine simulation**
   - **4.2. Validate and confirm stock removal strategies for multi-axis**
     - 4.2.a. Use stock compare simulation options to validate stock removal
   - **4.3. Review collisions for toolpath adjustments and confirm tool holder clearance**
     - 4.3.a. Review simulation results and determine collisions
   - **4.4. Apply lessons learned from verifications to toolpaths**
     - 4.4.a. Determine toolpath adjustments based on simulation results
5. Output code
   - **5.1. Verify the axis work coordinate setup against the posted code**
   - **5.2. Troubleshoot output errors**
6. Part inspection
   - **6.1. Given features in a multi-axis domain, validate feature location and size, and update machine parameters based on probing cycle output**
     - 6.1.a. Use probing and manual inspections to validate model features
   - **6.2. Apply concepts required to perform program prove out in a multi-axis machine**