2024-26 EDITION

SkillsUSA CHAMPIONSHIPS

CNC 3-AXIS MILLING PROGRAMMER

SkillsUSA Championships Technical Standards

PURPOSE

The purpose of this competition is to evaluate each competitor's skills to independently plan and program jobs and to provide instructions for 3-Axis Computer Numerical Control (CNC) milling machine operators to execute. The competition also seeks to recognize outstanding students for excellence and professionalism.

First, download and review the General Regulations at updates.skillsusa.org.

ELIGIBILITY

Open to active SkillsUSA members enrolled in programs with precision machining, automated manufacturing, or CNC as an occupational objective. Each state may send one high school and one college/postsecondary entry.

CLOTHING REQUIREMENTS

Class C: Competition Specific — Manufacturing/Construction Khaki Attire

- Official SkillsUSA khaki short-sleeve work shirt
- Khaki pants
- Black, brown or tan work shoes

Note: Safety glasses must have side shields or goggles. (Prescription safety glasses may be used only if they are equipped with side shields. If not, they must be covered with goggles.)

These regulations refer to SkillsUSA Championships Clothing Classifications that are pictured and described at skillsusastore.org. If you have questions about competition uniforms, call the SkillsUSA Store at 888-501-2183.

Note: Competitors must wear their official competition clothing to the competition orientation.

EQUIPMENT AND MATERIALS

1. Supplied by the technical committee:
   a. CAD/CAM software (Fusion 360 or Mastercam) and verification software (Vericut). Use the links below to request software for training and practice in advance of the competition
      1). Fusion 360
      2). Mastercam
      3). Vericut

   Note: Software license for Mastercam and Vericut (Fusion 360 license/account must be requested and installed prior to arriving at the competition)
   b. Laptops with pre-installed CAM software (Fusion 360 or Mastercam) and verification software (Vericut)
   c. Standard wired mouse
   d. Machinery's Handbook
   e. Pencils and paper
   f. NIMS Testing Center Account
2. Supplied by the competitor:
   a. Wi-Fi enabled laptop with USB-A port or adapter and pre-installed CAM and verification software
      1). National competitors may bring their own laptop with pre-installed CAM and verification software. Laptops may also be provided to national competitors upon request, form will be posted at updates.skillsusa.org after registration closes.
   b. Computer mouse (3-D mouse allowed)
   c. Hand-held scientific calculator
   d. All competitors must create and submit online a one-page single sided resume. See "Online Submission Requirements" below for guidelines. In addition to the online submission, competitors must also bring a hard copy of their resume to the competition.

***Note*:** All national competitors must also check for competition-specific updates and/or competitor preparation instructions on the SkillsUSA website at updates.skillsusa.org.

***Note**: Competitors not using Fusion 360 or Mastercam software **MUST** bring their own laptop with their preferred CAM software pre-installed and are responsible for obtaining software license(s) and post-processor(s) compatible with competition CNC machine(s).

***Note**: Typically, laptops are NOT provided to competitors in a local and/or state event. Be sure to check your state's competition updates for more information.*

PROHIBITED DEVICES

Cellphones, electronic watches and/or other electronic devices not approved by a competition's national technical committee are ***NOT*** allowed in the competition area. Please follow the guidelines in each technical standard for approved exceptions. Technical committee members may also approve exceptions onsite during the SkillsUSA Championships if deemed appropriate.

Penalties for Prohibited Devices

If a competitor's electronic device makes noise or if the competitor is seen using it at any time during the competition, an official report will be documented for review by the Director of the SkillsUSA Championships. If confirmed that the competitor used the device in a manner which compromised the integrity of the competition, the competitor's scores may be removed.

ONLINE SUBMISSION REQUIREMENTS

All SkillsUSA national competitors must submit their one-page single sided resume online. The deadline and link for online submissions will be published on updates.skillsusa.org.

Failure to submit any of the required document(s) listed below by the established deadline will result in a 10-point penalty.

1. One-page single sided resume

Your submission must be saved as PDF file type using the file name format of "Your Last Name_Your First Name_Resume." For example, "Amanda Smith" would save the individual PDF submissions file as:

- Smith_Amanda_Resume

SCOPE OF THE COMPETITION

KNOWLEDGE PERFORMANCE

The competition will include a test assessing knowledge of Computer Numerical Control milling programming in such areas as: safety, materials, measuring and test equipment, applied mathematics, engineering drawings, geometric dimensioning and tolerancing, machine technologies, controls navigation, cutting tool and holder technologies, computer operations and software technologies. Competitors are also required to take the SkillsUSA Professional Development Test.

SKILL PERFORMANCE

This competition will assess the ability to program CNC milling machines, interpret prints (including GDT), and measure/gauge parts. Competitors also will demonstrate theoretical knowledge of CNC machine configuration, setup, and operations.

COMPETITION GUIDELINES

1. Each competitor will be provided with the following technical documents to program a part using CAM software:
   a. Programming instructions
   b. Dimensional drawing and/or digital product definition data set
   c. Solid models
   d. Resource list (available CNC machine, part material, cutting tools, holders, and withholding devices)

2. Competitors demonstrate the following programming skills:
    a. Document process plans
    b. Create and/or modify solid models
    c. Align and position models in CAM programming environment
    d. Create 3-axis toolpaths
    e. Simulate program in virtual machine environment
    f. Post process NC program file(s)
    g. Create technical documentation
    h. Troubleshoot G-code errors
3. Competitor submits:
    a. NC program file(s)
    b. Tool list(s)
    c. Setup sheet(s)
    d. Process plan
4. Technical committee:
    a. Evaluates documents for required elements
    b. Runs and scores the part using a simulation software
    c. May run program on machine if simulation runs without safety violations, errors, or crashes
5. Competitor demonstrates ability to inspect sample parts
6. Competitor demonstrates ability to navigate CNC machine control to perform functions
7. Competitors are given the opportunity to familiarize themselves with CNC machines, the laptop, and software during orientation day with technical support experts on hand.

COMPETITION COMPONENTS

The CNC competition is divided into five main components:

1. CAM Programming: This component assesses a competitor's skills and knowledge in CNC programming. Competitors will use CAM software to program part features and generate NC file(s).
2. G-Code Troubleshooting: This component assesses a competitor's skills and knowledge in manual coding. Competitors will troubleshoot G-code programming errors.
3. CNC Technology Test: This is a theoretical/ test that assesses a competitor's knowledge in CNC technology.
4. Process Control Test: This component assesses a competitor's knowledge in quality control applications.
5. Employability: Mock interview to assess competitor's skills in obtaining employment.

STANDARDS AND COMPETENCIES

CNCM 1.0 — Process Planning: Formulate strategies to mill parts

1.1. Practical Application
    1.1.1. Process plan parts
    1.1.2. Document process plans

1.2. Critical Thinking
    1.2.1. Select machine tools
    1.2.2. Select workholding devices and accessories
    1.2.3. Select cutting tools and holders
    1.2.4. Determine extension out of holders (EOH) and length of cut (LOC)
    1.2.5. Determine process strategies
    1.2.6. Determine machining strategies
    1.2.7. Determine speeds and feeds

CNCM 2.0 — Modeling: Create and/or modify solid models

2.1. Practical Application
    2.1.1. Create sketches as necessary for toolpath guidance and containment
    2.1.2. Modify existing solid models
    2.1.3. Mate or position solid models
2.2. Critical Thinking
    2.2.1. Verify models

CNCM 3.0 — Toolpath Creation: Create toolpaths to mill parts

3.1. Practical Application
    3.1.1. Create toolpaths
    3.1.2. Simulate toolpaths in the CAM software
    3.1.3. Post-process
3.2. Critical Thinking
    3.2.1. Determine potential machine collisions
    3.2.2. Analyze cut parts for gouges
    3.2.3. Compare cut part against model

CNCM 4.0 — Coding: Write or edit G-code programs to machine parts or qualify workholding device accessories for machine setups

4.1. Practical Application
    4.1.1. Manually write G-code to requalify workholding devices
    4.1.2. Edit existing G-code programs
4.2. Critical Thinking
    4.2.1. Debug syntax and program errors

CNCM 5.0 — Program Verification: Verify programs in a virtual environment

5.1. Practical Application
    5.1.1. Simulate program in virtual machine environment
5.2. Critical Thinking
    5.2.1. Analyze cut parts for gouges
    5.2.2. Compare cut part against model
    5.2.3. Determine potential machine collisions

CNCM 6.0 — Documentation: Create technical documents required to communicate instructions required for machine operators to execute programs

6.1. Practical Application
  6.1.1. Create technical documents
6.2. Critical Thinking
  6.2.1. Evaluate documents to ensure content and format clearly communicated instructions

CNCM 7.0 — SkillsUSA Framework

The SkillsUSA Framework is used to pinpoint the Essential Elements found in Personal Skills, Workplace Skills and Technical Skills Grounded in Academics. Students will be expected to display or explain how they used some of these Essential Elements. For more, visit: www.skillsusa.org/who-we-are/skillsusa-framework/.

Source: NIMS *CAM Milling Programmer Standards. For more information, visit: https://www.nims-skills.org/machining-smart.*

COMMITTEE IDENTIFIED ACADEMIC SKILLS

The technical committee has identified that the following academic skills are embedded in this competition.

Math Skills

- Use fractions to solve practical problems
- Simplify numerical expressions
- Apply Pythagorean Theorem
- Solve problems using proportions, formulas, and functions
- Solve problems using trigonometry
- Solve problems using Cartesian coordinate system

CONNECTIONS TO NATIONAL STANDARDS

State-level academic curriculum specialists identified the following connections to national academic standards.

Math Standards

- Numbers and operations
- Algebra
- Geometry
- Measurement
- Problem solving
- Reasoning and proof
- Communication
- Connections

- Representation

Source: *NCTM Principles and Standards for School Mathematics. For more information, visit: http://www.nctm.org.*

Science Standards

- Understands the sources and properties of energy
- Understands forces and motion
- Understands the nature of scientific inquiry

Language Arts Standards

- Students adjust their use of spoken, written and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge
- Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion and the exchange of information)

Source: *IRA/NCTE Standards for the English Language Arts. To view the standards, visit: www.ncte.org/standards.*