



MECHATRONICS



SkillsUSA Championships Technical Standards

PURPOSE

To evaluate each team's preparation for employment and to recognize outstanding students for excellence and professionalism in the field of mechatronics. Mechatronics is a career and technical education discipline that combines the industrial skills of mechanics, electronics, and computer-based controls with a team-oriented approach to problem solving. Skilled mechatronic technicians are required for the maintenance, repair, and operation of modern automated manufacturing systems.

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

ELIGIBILITY (TEAM OF TWO)

Open to a team of two (2) active SkillsUSA members from the same local chapter (school) enrolled in programs with mechatronics technology as an occupational objective. Mechatronics technology includes programs with industrial electricity, fluid power technology, programmable logic controls (PLC) technology, and/or industrial automation as occupational objectives. Each state may send one high school and one college/postsecondary entry. A full team must be registered. See General Regulations for more information about substitution and penalty rules.

CLOTHING REQUIREMENTS

Class C: Competition Specific — Manufacturing/Construction Khaki Attire

- Official SkillsUSA khaki short-sleeve work shirt
- Khaki pants
- Black, brown, or tan safety 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. All specialized tools, materials, and equipment needed for the competition.
2. Supplied by competitors:
 - a. One (1) PLC assembly. The PLC assembly must meet the following requirements:
 - 1). Power supply: The PLC must be capable of operating at 24VDC, or 120VAC - rated for 5 Amps. All 120VAC units must be wired ahead of time to an in-line ground-fault interrupter device and standard (NEMA 5-15P) 120VAC line cord. All 120VAC wiring must meet PLC manufacturer's requirements and follow standard industry practice. Judges reserve the right to disallow the use of any competitor-supplied equipment that presents a safety hazard. No line cords or 120VAC wiring devices will be supplied at the competition.
 - 2). PLC shall have a minimum of 16 digital inputs and 16 digital outputs.
 - 3). Inputs shall be 24VDC Sinking (inputs shall be activated by application of a +24VDC signal to the input terminal).
 - 4). Outputs shall be 24VDC Sourcing (outputs shall supply a +24VDC signal to the load when activated). All loads will be returned to ground. Output capacity shall be no less than 0.5A, each.
 - b. Basic hand tools: Pliers, needle nose pliers, wire cutters, wire strippers, hex keys, screw drivers, nut drivers (metric and imperial for all tools)
 - c. Digital multimeter
 - d. One 6' multiple-outlet surge protector
 - e. All competitors must create and submit online a one-page single sided resume. See "Online Submission Requirements" below for guidelines.

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: Terminal blocks and wire will be provided by the technical committee. Competitors will wire their PLC I/O points to these blocks, per instructions given out at the orientation meeting. Competitors and advisors can connect to a data cable and ensure communication with their PLC.

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 general knowledge of mechatronics technology. Questions pertaining to mechanics, industrial electricity, fluid power systems (pneumatic and hydraulic), and programmable controllers may be included. Competitors are also required to take the SkillsUSA Professional Development Test

SKILL PERFORMANCE

The competition includes an oral assessment and multiple challenges, including troubleshooting and construction projects. Teams of two, in a timed event, will accurately and neatly perform system troubleshooting and repair a faulty machine system. In this event, general interdisciplinary knowledge of the individual technologies and interactions in an integrated system will be examined by the judges.

COMPETITION GUIDELINES

1. Teams will be required to write a PLC program. This necessitates each team to provide its own PLC assembly and programming device/software (e.g., laptop computers or hand-held programming devices).
2. The competition will consist of various tasks selected from the list of standards and competencies.
3. Teams can freely choose who performs tasks separately or together.
4. Teams will be rotated through identical stations with time limits.
5. The judging criteria and the points assigned will be determined by the difficulty of the task.
6. The team's ability to effectively communicate the operation and behavior of mechatronics systems or sub-systems and to analyze a circuit diagram will be evaluated.

7. Teams will be tested on familiarity with ISO symbols, interpretation of relationships between components, and ability to develop sequential operations.

STANDARDS AND COMPETENCIES

MECH 1.0 — Read and interpret technical drawings of various types

- 1.1. Read and interpret electrical schematics.
- 1.2. Read and interpret mechanical drawings.
- 1.3. Read and interpret fluid power circuit diagrams.

MECH 2.0 — Build a mechatronic device based upon given specifications

- 2.1. Use measurement tools.
- 2.2. Select fasteners to mount components.
- 2.3. Use appropriate wires to make correct electrical connections.
- 2.4. Use appropriate tubing to make pneumatic connections.
- 2.5. Employ best practices in laying out wires and tubes for neatness, security and safe operation.
- 2.6. Adjust subsystems by utilizing interdisciplinary skills.
- 2.7. Employ proper safety equipment and practice.

MECH 3.0 — Identify and troubleshoot competition modified mechanical, pneumatic, electrical and electronic components

- 3.1. Use resistance, voltage, and current to test electrical equipment properly.
- 3.2. Install, service, adjust and troubleshoot pneumatic systems.
- 3.3. Install, adjust and troubleshoot electro-pneumatic systems.
- 3.4. Given different components, identify component faults and determine if repair or replacement is needed.
- 3.5. Successfully answer knowledge test.

STANDARDS AND COMPETENCIES: HIGH SCHOOL

MECH-HS 4.0 — Install and Program a PLC

- 4.1. Properly define names and create tables of inputs/outputs needed.
- 4.2. Connect appropriate wires to each input and output.
- 4.3. Develop a logical sequence of operation through use of a sequential function chart
- 4.4. Develop, debug, and download a PLC program designed to make the system function according to plan using proper software and interfaces

MECH-HS 5.0 — Robot Program and Integration

- 5.1. Proper installation of the robot with usage of the robot's coordinate systems, loading and execution of a pre-written robot program (adjusting preset points)
- 5.2. Robot I/O wiring, testing and verification for proper operation of the connected I/O device.

- 5.3. Install and configure various end effectors (i.e. grippers, sensors) for specific tasks, understand and use the robot's tool coordinate systems
- 5.4 Identify and apply safety procedures for robot operation, perform routine maintenance checks and procedures, and troubleshoot and resolve common operational issues.

STANDARDS AND COMPETENCIES: COLLEGE/POSTSECONDARY

MECH-CPS 4.0 — Install and Program a PLC

- 4.1. Identify input and output terminals on the PLC.
- 4.2. Connect appropriate wires to each input and output.
- 4.3. Develop, debug, and download a PLC program designed to make the system function according to plan using proper software and interfaces.
- 4.4. Develop short-subroutines and/or function blocks to make the system function smoothly according to the prescribed plan.

MECH-CPS 5.0 — Installation and Program of a robot with a PLC

- 5.1 Write, test, and optimize a program using the appropriate software tools for both efficiency and accuracy (i.e. robot path planning)
- 5.2 Write, test and optimize a PLC program to control the robotics system, efficiently and Reliably.
- 5.3 Establish communication, test the I/O interaction and develop integrated control programs between the robot and the PLC.

MECH 6.0 — 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/.

COMMITTEE IDENTIFIED ACADEMIC SKILLS

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

Math Skills

- Solve single variable algebraic expressions.
- Make comparisons, predictions and inferences using graphs and charts.
- Organize and describe data using matrices.

Science Skills

- Understand Law of Conservation of Matter and Energy.
- Use knowledge of potential and kinetic energy.
- Use knowledge of mechanical, chemical and electrical energy.
- Use knowledge of heat, light and sound energy.

- Use knowledge of principles of electricity and magnetism.
- Use knowledge of static electricity, current electricity and circuits.
- Use knowledge of magnetic fields and electromagnets.

Language Arts Skills

- Demonstrate comprehension of a variety of informational texts.
- Use text structures to aid comprehension.
- Demonstrate knowledge of appropriate reference materials.
- Use print, electronic databases and online resources to access information in books and articles.

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 read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.
- Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and

their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics).

- 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.