



## 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.

### ELIGIBILITY (TEAM OF TWO)

Open to a team of two active SkillsUSA members 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.

### 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 glasses may be used only if they are equipped with side shields. If not, they must be covered with goggles.)

These regulations refer to clothing items that are pictured and described at [www.skillsusastore.org](http://www.skillsusastore.org). If you have questions about clothing or other logo items, call 1-888-501-2183.

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

## EQUIPMENT AND MATERIALS

### REQUIREMENTS FOR ALL LEVEL TEAMS:

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. 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). The PLC assembly must meet the following requirements:
    - 1). Power supply: The PLC must be capable of operation 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 (metric and imperial), screw drivers.
  - c. Digital multimeter
  - d. One 6' multiple-outlet surge protector
  - e. All competitors must create a one-page resume. See "Resume Requirement" below for guidelines.

**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 will be allowed to connect a data cable and ensure communication with their PLC at this time.

### RESUME REQUIREMENT

Competitors must create a one-page resume to submit online. SkillsUSA South Carolina competitors should submit their resume by the deadline published on the competition updates page of our website. Failure to submit a resume will result in a 10-point penalty.

Your resume must be saved as a PDF file type using file name format of "Last Name\_First Name." For example, "Amanda Smith" would save her resume as Smith\_Amanda. If you need assistance with saving your file as a PDF, visit the Adobe website for more information.

Note: Check the Competition Guidelines and/or the updates page on the state website.

## **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.

## **SCOPE OF THE COMPETITION**

### **KNOWLEDGE PERFORMANCE**

The competition will include a written knowledge exam assessing general knowledge of mechatronics technology. Questions pertaining to mechanics, industrial electricity, fluid power systems (pneumatic and hydraulic), and programmable controllers may be included.

### **SKILL PERFORMANCE**

The competition includes an oral assessment and multiple challenges, including but not limited to a troubleshooting and construction project. Teams of two competitors, 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. The competition will be a team-oriented event. Teams will consist of two competitors from the same school in the same division.
2. The competition will consist of various tasks selected from the list of standards and competencies as determined by the SkillsUSA Championships technical committee. Committee membership includes Festo Corp.
3. Teams can freely choose who performs tasks separately or together.
4. Competitors will be rotated through identical stations with time limits determined by the national technical committee.
5. The judging criteria and the points assigned will be determined by the difficulty of the task assigned.
6. The oral examination assesses the team's ability to effectively communicate the operation and behavior of Mechatronics systems or sub-systems and to analyze a circuit diagram.

7. Competitors will be tested on familiarity with ISO symbols, interpretation of relationships between components, and ability to develop sequential operations.
8. 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).

## **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. Adjust and calibrate subsystems by using interdisciplinary skills.
- 2.8. 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, adjust and troubleshoot programmable logic controllers and systems.
- 3.3. Select and install threaded fasteners.
- 3.4. Perform precision measuring on mechanical components.
- 3.5. Install, service, adjust and troubleshoot pneumatic and hydraulic systems.
- 3.6. Install, adjust and troubleshoot electro- pneumatic and electro-hydraulic systems.
- 3.7. Read construction, electrical and mechanical blueprints.
- 3.8. Successfully answer a 50- to 100-question test.

## **Secondary:**

### **MECH 4.0 — Install a PLC**

- 4.1. Identify and label input and output terminals on the PLC.
- 4.2. Connect appropriate wires to each input and output.

### **MECH 5.0 — Program a PLC**

- 5.1. Properly define names and create tables of any inputs/outputs needed.
- 5.2. Develop a logical sequence of operation through use of a sequential function chart
- 5.3. Develop, debug, and download a PLC program designed to make the system function according to plan using proper software and interfaces

## College/Postsecondary:

### MECH 4.0 — Install a PLC (college/postsecondary only)

- 4.1. Identify input and output terminals on the PLC.
- 4.2. Connect appropriate wires to each input and output.
- 4.3. Connect the wires to the applicable actuators and sensors.

### MECH 5.0 — Program a PLC (college/postsecondary only)

- 5.1. Develop, debug and download a PLC program designed to make the system function according to plan using proper software and interfaces.
- 5.2. Develop Short-subroutines and/or function blocks to make the system function smoothly according to the prescribed plan.

### 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. Please reference the graphic, as you may be scored on specific elements applied to your project. For more, visit: [www.skillsusa.org/who-we-are/skillsusa-framework/](http://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.

*Source: McREL compendium of national science standards. To view and search the compendium, visit: [www2.mcrel.org/compendium/](http://www2.mcrel.org/compendium/).*

### **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](http://www.ncte.org/standards).*