

# MECHATRONICS



## 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 educational 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.

Because of the popularity of PLC controls in industry, new for 2020 is the addition of PLC exercises for schools at the secondary level.

First, download and review the General Regulations at: [updates.skillsusa.org](http://updates.skillsusa.org).

## ELIGIBILITY (TEAM OF 2)

Open to active SkillsUSA members enrolled in Mechatronics technology programs as the occupational objective. Where this program is not yet available, students may compete if they are enrolled in industrial electricity, fluid power technology, programmable logic controls (PLC) technology or industrial automation programs.

## CLOTHING REQUIREMENTS

### Class C: Contest Specific — Manufacturing/Construction Khaki Attire

- Official SkillsUSA khaki short-sleeve work shirt and pants
- Black, brown or tan leather 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 800-401-1560 or 703-956-3723.

**Note:** Contestants must wear their official contest clothing to the contest orientation meeting.

## EQUIPMENT AND MATERIALS

Requirements for Secondary/High School Team

1. Supplied by the technical committee:
  - a. All specialized tools, materials and equipment needed to compete in the contest
  - b. 24VDC, 3A power supply
2. Supplied by contestants:
  - a. All competitors must create a one-page résumé and submit a hard copy to the technical committee chair at orientation. Failure to do so will result in a 10-point penalty.
  - b. A PLC or logic controller, including all necessary software and computer to program said device. The controller must have a minimum of six (6) digital inputs and four (4) digital outputs. Inputs shall be 24VDC Sinking (inputs shall be activated by application of a +24VDC signal to the input terminal). 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. Check with your local vendor for suitable alternatives.

**Note:** Your contest may also require a hard copy of your résumé as part of the actual contest. Check the Contest Guidelines and/or the updates page at: [updates.skillsusa.org](http://updates.skillsusa.org).

Requirements for College/Postsecondary Team  
Supplied PLC Assemblies

In addition to the previous list, the following are supplied by college/postsecondary contestants only:

1. One (1) PLC assembly. Teams competing at the college/ postsecondary level will be required to write a PLC program. This necessitates each college/postsecondary 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:

- a. Power supply: The PLC must be capable of operation at 24VDC, or 120VAC. 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 contestant-supplied equipment that presents a safety hazard. No line cords or 120VAC wiring devices will be supplied at the contest.
- b. PLC shall have a minimum of 16 digital inputs and 16 digital outputs.
- c. Inputs shall be 24VDC Sinking (inputs shall be activated by application of a +24VDC signal to the input terminal).
- d. 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.

No Analog I/O will be required.

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

## SCOPE OF THE CONTEST

### Knowledge Performance

The contest will include a 50- to 100-question written knowledge exam assessing general knowledge of Mechatronics technology. Questions pertaining to mechanics, industrial electricity, fluid power systems (pneumatic and hydraulic) and programmable controllers will be included.

### Skill Performance

The contest includes an oral assessment and multiple challenges, including but not limited to a troubleshooting and construction project. Teams of two contestants, 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.

### Contest Guidelines

1. The contest will be a team-oriented event. Teams will consist of two contestants from the same school in the same division.
2. The contest 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. Contestants 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. Contestants will be tested on familiarity with ISO symbols, interpretation of relationships between components, and ability to develop sequential operations.
8. Teams competing at the college/postsecondary level will be required to write a PLC program. This necessitates each college/postsecondary 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 blueprints

- 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 — Mechanical devices**

- 3.1 Calculate belt and pulley diameters to obtain desired speed and torque parameters
- 3.2 Use specialized tools to measure speeds of motors and other mechanical devices
- 3.3 Use specialized tools to make adjustments on mechanical subsystems, including physical alignment and belt/chain tensions

**MECH 4.0 — Identify and troubleshoot contest modified mechanical, pneumatic, electrical and electronic components**

- 4.1 Use resistance, voltage, and current to test electrical equipment properly
- 4.2 Install, adjust and troubleshoot programmable logic controllers and systems
- 4.3 Select and install threaded fasteners
- 4.4 Perform precision measuring on mechanical components
- 4.5 Install, service, adjust and troubleshoot pneumatic and hydraulic systems
- 4.6 Install, adjust and troubleshoot electro-pneumatic and electro-hydraulic systems
- 4.7 Read construction, electrical and mechanical blueprints
- 4.8 Successfully answer a 50- to 100-question test

**College/postsecondary students will also:**

**MECH 5.0 — Install a PLC**

- 5.1 Identify input and output terminals on the PLC
- 5.2 Connect appropriate wires to each input and output
- 5.3 Connect the wires to the applicable actuators and sensors

**MECH 6.0 — Program a PLC**

- 6.1 Develop, debug and download a PLC program designed to make the system function according to plan using proper software and interfaces

**Committee Identified Academic Skills**

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

**Math Skills**

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

**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/browse.asp](http://www2.mcrel.org/compendium/browse.asp).

#### **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).