

ROBOTICS AND AUTOMATION TECHNOLOGY (VIRTUAL)



PURPOSE

To evaluate each contestant's preparation for employment in the emerging arena of robotics and automation with emphasis on the team approach to problem-solving in a work environment. To recognize outstanding performance in the use of new work styles and technology by contestants.

First, download and review the General Regulations at: <http://updates.skillsusa.org>.

ELIGIBILITY (TEAM OF 2)

Open to active SkillsUSA members enrolled in programs with robotics, automation and/or manufacturing as the occupational objective.

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).

Contest Clothing Notes (Apply ONLY to Virtual Competitions):

- Official SkillsUSA Competition Clothing recommended but NOT required.
- Contestant clothing options include the following:
 - Official Competition Clothing.
 - Trade Appropriate Clothing.
 - Professional Dress.
 - Business Casual.
- Clothing must meet industry safety standards.

- No identification of the contestant, school or state is allowed on clothing.
- No offensive, vulgar or inappropriate images or text are allowed on contestants clothing.
- No shorts or sleeveless shirts are allowed.
- Skirts must be at least knee-length.
- Proper Personal Protective Equipment (PPE) must be worn by contestant to meet all state, local and school requirements due to COVID-19.
- Scoring deductions may only be given and/or disqualification of contestant if clothing safety standards are not met.

These regulations refer to clothing items that are pictured and described at: www.skillsusa.org. If you have questions about clothing or other logo items, call 800-401-1560 or 703-956-3723.

EQUIPMENT AND MATERIALS

Supplied by contestants:

1. Necessary equipment to construct the work cell that is designed by the technical committee for the contest task.
2. Computer with high-speed internet capability and camera to use applications such as Zoom, Teams, etc. The minimum recommended internet bandwidth speeds for joining Zoom meetings, accessing on-demand curriculum and other online operations is 2.0 Mbps up and down. You can test your current internet speeds by following this link: <https://www.speedtest.net/>. Allow the page to load and click on GO.
3. A secondary camera(s) may be required to provide judges with the ability to view contestants from different angles. Additional camera requirements will be located on the SkillsUSA website at <http://updates.skillsusa.org>.
4. A contest Proctor will be required to be on site to assist judges. A local industry expert is preferred to serve as the Proctor and shall not be an individual that has been involved with the training of the contestant(s). The Proctor will serve as the onsite "hands and eyes" for the judges. Proctor will follow instructions from the judges for safety and operations related to

the competition. Proctor may be asked by judges to perform several tasks such as operating a portable camera to show specific components or steps, measure parts, or any task that will provide judges with information needed to assist in accurate scoring of the contestant's work or presentation. However, the Proctor shall not serve as a judge nor have any influence on contestant scores.

5. The contestant's instructor or advisor shall be on site to observe all competition activities to ensure a safe and healthy competition experience for all participants. That instructor or advisor will not be allowed to interact or interfere with the competitor unless a safety issue arises that requires interaction. Any other support or interaction between the contestant and the instructor/advisor will result in disqualification
6. All competitors must create a one-page résumé and submit an electronic copy to the technical committee chair at least seven (7) days in advance of the competition. Failure to do so will result in a 10-point penalty. Instructions for submission of the electronic résumé copy will be provided on the SkillsUSA website at <http://updates.skillsusa.org>.
7. Necessary equipment:
 - a. Computer (as listed above)
 - b. Wire cutters/diagonals 3" to 6"
 - c. Screwdrivers (3" to 6" blade length)
 1. Common set to include $\frac{1}{8}$ ", $\frac{1}{4}$ " and $\frac{3}{8}$ " minimum
 2. Phillips set to include No. 0, No. 1 and No. 2 minimum
 - d. Long nose/needle nose pliers 3" to 6"
 - e. Wire strippers
 - f. Safety glasses — clear lenses (two pairs)
 - g. Hookup wire, 20–24 AWG, red, black yellow, blue and green (other colors may be substituted), 150' each color
 - h. Allen wrenches, set to include 5mm, 3mm and $\frac{7}{64}$ " minimum
 - i. Multimeter with leads
 - j. Two pencils (sharpened)
 - k. 6" or 12" ruler
 - l. Power screwdriver or drill with screwdriver bits to mount fixtures to work surface

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 on the SkillsUSA website at updates.skillsusa.org.

Note: Each team must supply at least one laptop computer to complete programming required. The computer should have all security software disabled and the team should have any necessary passwords for the machine.

Please check the SkillsUSA Championships update page (<http://updates.skillsusa.org>) to see any applicable changes that apply to the task for that year.

Computer Specifications:

Each team is to provide one computer with the following minimum specifications:

- Intel Core i3 (sixth generation or newer) or equivalent.
- CD-ROM drive.
- 4 GB RAM (or more).
- 100 MB available on the hard disk.
- Windows 10 Operating System.
- 15" LCD monitor.
- Network adapter.
- Mouse.
- 2 available USB ports.
- USB Flash Drive.

SCOPE OF THE CONTEST

1. Teams must be comprised of two students who will demonstrate their ability to compile and perform the skills and knowledge as determined by the technical committee.
2. The teams will be provided with a detailed description of the tasks and objectives required for an automated robotic workcell.
 - a. Setting up an automated robotic workcell
 1. Graphically assemble robotic workcell
 2. Establish communication between computer and robot
 3. Establish communication with peripheral equipment, which may include a PLC and Vision Sensor

4. Document all I/O connections and robot positions for approval by judges
- b. Creating robot positions and verifying safe arm travel
 1. Determine minimum number of positions required to perform assigned tasks
 2. Lay out robot within the workcell for maximum efficiency
 3. Teach and record each required position
 4. Verify arm path between positions
- d. Programming of robot and PLC
 1. Determine sequencing and logic
 2. Determine input/output communication logic
 3. Write robot and PLC program

Team Organization Goal

This is a team competition, and members may interact at will. The competition will be conducted as performed in industry. The robot operators will locate and position the robot to specific locations, and the programmers will tell the robot exactly what is expected and when to perform specific functions. The contest is designed to promote creativity in the organization of production responsibility.

All team members are responsible for double-checking each other's work and quality control.

General Information

There will be a three-hour practice session one day prior to the contest. During this practice session, students and teachers will have the opportunity to verify computer compatibility with software provided. The computers will be set up to allow students to write a sample program and ask the contest officials questions on the practice day. There will be a written exam on the practice day.

Note: The judging criteria and the points assigned will be determined by the technical committee each year.

Knowledge Performance

The contest will include a written exam and oral presentation assessing competitors' knowledge of the principles of robotics, automation technology and safety practices.

Skill Performance

Students will work in teams of two from the same school to create a robotic workcell.

Contest Guidelines

1. Teams must be comprised of two students who will demonstrate their ability to compile and perform the skills and knowledge as determined by the technical committee.
2. Teams are given a task that they will solve using a vertically articulated five-axis robot and additional peripherals used to create a workcell.
3. Each team will be required to provide documentation of its proposed workcell, based on the design criteria provided.
4. Teams will present the proposed workcell to the judges for approval and be given the go-ahead to implement their design.
5. Students will present their implemented workcell, including any changes to their original design.
6. The workcell will be judged based on hardware layout, wiring, power and external devices such as sensors and pneumatic actuators.
7. The robot will be fully functional with a program based on their original program design (flowchart). This will include the robot program, positions that tell the robot exactly what is expected and when to perform specific functions.
8. The contest is designed to mirror industry, promoting creativity using a standard design and organization of production responsibility. All team members are responsible for double-checking each other's work and quality control.
9. On the day before the competition, there will be an orientation/practice for all teams. Teams must bring the equipment listed above to the orientation on Tuesday. Each team will have a three-hour practice session. During this practice session, students and teachers will have the

opportunity to verify computer compatibility with the equipment.

10. The written exam may be held on the same day as the practice session.

Standards and Competencies

Note for Virtual Competitions: Contestants may not be required to perform all the standards and competencies listed in this section. However, contestants should be prepared to perform components in all areas. Prior to the competition, the technical committee may determine which standards and competencies contestants will perform for the virtual contests. The technical committee will determine if additional information is needed for contestants prior to the competition. These changes will be posted on the SkillsUSA Championships contest update website at: <http://updates.skillsusa.org>.

RAT 1.0 — Demonstrate knowledge in safety rules and practices

- 1.1 Maintain a safe work area

RAT 2.0 — Demonstrate ability to read and interpret electrical drawings

- 2.1 Interpret electric circuits used in a robotic workcell

RAT 3.0 — Produce examples of basic computer programming and flowcharting in a given scenario

- 3.1 Draw program flow chart using appropriate symbols representing robot program
- 3.2 Develop basic computer program to control robot and peripherals

RAT 4.0 — Demonstrate electrical wiring in a robotic work cell

- 4.1 Wire and connect different types of sensors used in a workcell, including contact and inductive proximity sensors
- 4.2 Wire and connect output devices such as warning lights, solenoids and relays and pneumatic actuators

RAT 5.0 — Create appropriate documentation used in a robotic work cell

- 5.1 Define and document all safety issues
- 5.2 Document and describe system (workcell) layout
- 5.3 Describe and document controller input and output devices including peripheral device connections, input, output, program positions, wiring diagrams and system layout

RAT 6.0 — Write and verify a robot program

- 6.1 Develop a flowchart that outlines a robot program based on customer specifications
- 6.2 Develop a robot program based on customer specifications
- 6.3 Use program subroutines, variables and appropriate program remarks when developing a robot program
- 6.4 Design interfacing to input and output devices
- 6.5 Document workcell positions and show the standards used
- 6.6 Program the use of a pneumatic part feeder and press
- 6.7 Program the use of a conveyor
- 6.8 Demonstrate consideration for operation and maintenance of robot

Committee Identified Academic Skills

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

Math Skills

- Use fractions to solve practical problems.
- Use proportions and ratios to solve practical problems.
- Simplify numerical expressions.
- Use scientific notation.
- Solve practical problems involving percentages.
- Solve single variable algebraic expressions.
- Solve multiple variable algebraic expressions.
- Measure angles.
- Apply transformations (rotate or turn, reflect or flip, translate or slide and dilate or scale) to geometric figures.
- Construct three-dimensional models.

- Make comparisons, predictions and inferences using graphs and charts.
- Organize and describe data using matrixes.
- Solve problems using proportions, formulas and functions.
- Use measures of interior and exterior angles of polygons to solve problems.
- Find arc length and the area of a sector.

Science Skills

- Plan and conduct a scientific investigation.
- 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 temperature scales, heat and heat transfer.
- Use knowledge of sound and technological applications of sound waves.
- Use knowledge of the nature and technological applications of light.
- Use knowledge of speed, velocity and acceleration.
- Use knowledge of Newton's laws of motion
- Use knowledge of work, force, mechanical advantage, efficiency and power.
- Use knowledge of simple machines, compound machines, powered vehicles, rockets and restraining devices.
- Use knowledge of principles of electricity and magnetism.
- Use knowledge of static electricity, current electricity and circuits.
- Use knowledge of magnetic fields and electromagnets.
- Use knowledge of motors and generators.

Language Arts Skills

- Provide information in conversations and in group discussions.
- Provide information in oral presentations.
- Demonstrate use of such verbal communication skills as word choice, pitch, feeling, tone and voice.
- Demonstrate use of such nonverbal communication skills as eye contact, posture and gestures using interviewing techniques to gain information.
- Analyze mass media messages.
- Demonstrate comprehension of a variety of informational texts.

- Use text structures to aid comprehension.
- Identify words and phrases that signal an author's organizational pattern to aid comprehension.
- Understand source, viewpoint and purpose of texts.
- Organize and synthesize information for use in written and oral presentations.
- Demonstrate knowledge of appropriate reference materials.
- Use print, electronic databases and online resources to access information in books and articles.
- Demonstrate narrative writing.
- Demonstrate informational writing.
- Edit writing for correct grammar, capitalization, punctuation, spelling, sentence structure and paragraphing.

Connections to National Standards

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

Math Standards

- Numbers and operations.
- Algebra.
- 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: <http://www2.mcrel.org/compendium/browse.asp>.

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.