

# ROBOTICS AND AUTOMATION TECHNOLOGY



## 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).

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

1. Supplied by technical committee:
  - a. Necessary equipment to construct the workcell that is designed by the technical committee for the contest task.
2. Supplied by contestants:
  - a. Necessary equipment:
    1. Computer
    2. Wire cutters/diagonals 3" to 6"
    3. Screwdrivers (3" to 6" blade length)
      - a. Common set to include 1/8", 1/4" and 3/8" minimum
      - b. Phillips set to include No. 0, No. 1 and No. 2 minimum
    4. Long nose/needle nose pliers 3" to 6"
    5. Wire strippers
    6. Safety glasses — clear lenses (two pairs)
    7. Hookup wire, 20–24 AWG, red, black yellow, blue and green (other colors may be substituted), 150' each color
    8. Allen wrenches, set to include 5mm, 3mm and 7/64" minimum
    9. Multimeter with leads
    10. Two pencils (sharpened)
    11. 6" or 12" ruler
    12. Power screwdriver or drill with screwdriver bits to mount fixtures to work surface
  - b. 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.

**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 <http://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.

Contestants are asked to check the SkillsUSA Championships April 15 update (<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. 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. Working with hand tools and integrating peripherals
    1. Wiring communication between robot and computer
    2. Wiring communication between peripherals (power supply, light stack and sensors)
    3. Verify electronic connections using a multimeter

- c. 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. Develop logic diagram
  4. 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 six-hour practice session (with one hour for lunch) one day prior to the contest. During this practice session, students and teachers will have the opportunity to verify computer compatibility with equipment provided. *Students must bring their toolboxes and safety glasses to the practice day.* They will be able to configure, hardwire wire and apply power to test out the hardware. 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. Contestants are required to adhere to industry safety standards using the hardware and software provided.
10. All equipment provided by the technical committee will be in place and set up on the Monday before the competition begins. On the Tuesday before the competition, there will be an orientation/practice for all

teams. Teams must bring the equipment listed above to the orientation on Tuesday. Space will be made available for the teams to leave their tools in the competition area. Each team will have a three-hour practice session with one hour for lunch. During this practice session, students and teachers will have the opportunity to verify computer compatibility with the equipment provided.

11. The written exam will be held on the same day as the practice session.
12. During the practice period or the days of the competition, tampering with or removing any of the equipment provided is grounds for disqualification.

## **Standards and Competencies**

### **RAT 1.0 — Demonstrate knowledge in safety rules and practices**

- 1.1 Maintain a safe work area
- 1.2 Demonstrate correct use of hand tools
- 1.3 Follow safety rules during installation and layout of a robotic workcell
- 1.4 Program robot and PLC with appropriate use of safety devices

### **RAT 2.0 — Demonstrate ability to read and interpret electrical drawings**

- 2.1 Interpret electric circuits used in a robotic workcell
- 2.2 Wire series and parallel electric circuits
- 2.3 Set up and operate DVM

### **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 Adhere to electrical and safety standards
- 4.2 Use the appropriate hand tools and electrical wiring standards
- 4.3 Wire and connect different types of sensors used in a workcell, including contact and inductive proximity sensors

- 4.4 Wire and connect output devices such as warning lights, solenoids and relays and pneumatic actuators

**RAT 5.0 — Install and adjust any electro-pneumatic devices provided**

- 5.1 Adhere to safety practices  
5.2 Use the appropriate hand tools and electric wiring standards  
5.3 Wire and connect sensors used in a workcell

**RAT 6.0 — Create appropriate documentation used in a robotic work cell**

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

**RAT 7.0 — Write and verify a robot and PLC program**

- 7.1 Develop a flowchart that outlines a robot program based on customer specifications  
7.2 Develop a robot program based on customer specifications  
7.3 Use program subroutines, variables and appropriate program remarks when developing a robot program  
7.4 Design interfacing to input and output devices  
7.5 Document workcell positions and show the standards used  
7.6 Program the use of a pneumatic part feeder and press  
7.7 Program the use of a conveyor  
7.8 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](http://www.ncte.org/standards).