2022-23 EDITION

SkillsUSA CHAMPIONSHIPS

ROBOTICS: URBAN SEARCH AND RESCUE

SkillsUSA Championships Technical Standards

PURPOSE

To evaluate each competitor's preparation for employment and to recognize outstanding students for excellence and professionalism in the field of robotics.

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

ELIGIBILITY (TEAM OF TWO)

Open to active SkillsUSA members enrolled in programs with robotics, engineering, automation, manufacturing, electronics, and emergency services as the occupational objectives. Each state may send one middle school, one high school and one college/postsecondary team.

CLOTHING REQUIREMENTS

Class E: Competition Specific — Business Casual

- Official SkillsUSA white polo shirt
- Black dress slacks or black dress skirt (knee-length minimum)
- Black closed-toe dress shoes

Note: Wearing socks or hose is no longer required. If worn, socks must be black dress socks and hose must be either black or skin-tone and seamless/nonpattern.

These regulations refer to clothing items that are pictured and described at 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

1. Supplied by technical committee:
   a. Challenge field: 30' x 40' simulated neighborhood
   b. Field elements: components of a residential area and obstacles to traverse, open, and manipulate in order to locate and dispose of simulated explosive ordnances
   c. A command center area equipped with a table, a driver chair, spotter area, video monitor, and two-way communication equipment for driver and spotter.
   d. General workspace for each team designated as a "pit" area, including one table, two chairs, and access to a 120-volt electrical supply
2. Supplied by the competitor:
   a. Safety equipment — eye protection is required at all times in the competition area
   b. Laptop computer (optional) for technical presentation purposes only. Laptop not used for robot operation.
   c. Fully assembled, tested, and operational ordnance disposal robot conforming to the guidelines and parts restrictions listed in this document (see "Urban Search and Rescue Challenge Kit Bill of Materials" in Appendix)
   d. Team number affixed to robot
   e. Presentation software for oral presentation to judges (optional)
   f. CAD/CAM software for blueprint design (optional)
   g. Completed Engineering Notebook
      Note: Technical drawing/blueprint of robot drive chassis must be included in notebook
   h. Pens, pencils and paper
   i. One 6' multiple-outlet surge protector
   j. Tools:
      1.) Allen wrench set (English)
      2.) Clamping vise
      3.) Metal tin snips
      4.) Power strip
      5.) Calculator
      6.) Tape measure
      7.) Hammer
      8.) Metal file
      9.) Flat-head and Phillips-head screwdrivers
      10.) Wire strippers (one set)
      11.) Wire cutters/snips (one set)
      12.) Roll of electrical tape
      13.) 4" nylon wire ties (25 pack)
      14.) Multimeter
      15.) Multi-nut pliers
      16.) Metal-cutting hacksaw (manual)
      17.) Cordless drill with charger
      18.) Set of standard drill bits
      19.) Pliers (needle nose or regular)
      20.) Set of box wrenches
   k. All competitors (except for middle school students) must create a one-page resume. See "Resume Requirement" below for guidelines.

RESUME REQUIREMENT

Competitors (except for middle school students, who are exempt from this requirement) must create a one-page resume to submit online. SkillsUSA national competitors should submit their resume by June 1. The link for submission will be published on http://updates.skillsusa.org on May 1. 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 SkillsUSA website at http://updates.skillsusa.org.

PROHIBITED DEVICES

Cell phones 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 SkillsUSA Championships director. If confirmed that the competitor used the device in a manner which compromised the integrity of the competition, the competitor's scores may be canceled.

SCOPE OF THE COMPETITION

KNOWLEDGE PERFORMANCE

This portion of the competition will entail a knowledge exam. Competencies evaluated on the written portion will be general principles used in robotics. There will be a 30-minute limit for the written test. Competitors are also required to take the SkillsUSA professional development test. Middle school competitors are exempt from testing requirements.

SKILL PERFORMANCE

A two-member team builds its robot and arm mechanism prior to the competition and then, during the competition, there will be two separate but related challenges. The first will be a demonstration of proficiency in five specific skill trials. The second is a simulated urban search and rescue mission to traverse a course and locate, secure, and properly dispose of ordnances. Both challenges will require teams to demonstrate proficiencies such as remotely operating the robot via camera, navigation, manipulating the arm mechanism to collect simulated ordnances, traversing various types of terrain, and communication between driver and spotter. Each team will perform one round of the five skill trials and one round of the simulated mission to locate

and dispose of two ordnances. In both challenges, teams will be under time constraints to complete the objective.

COMPETITION GUIDELINES

1. Teams must be composed of two students. If a team member is absent, the lone team member will be allowed to compete, but a 30-point penalty will be applied to the overall score.
2. Each robot must have an identification label with the team's number listed.
3. Each technical presentation should last for a maximum of five minutes and should be primarily oral, with supporting materials of printed or electronic media and physical models. Competitors should be prepared to answer questions from the judges after they have completed their full presentation. After five minutes, the presentation will end with no penalty assessed to the team score. Students should be prepared to discuss the roles they played, their robot design, and the functions of their robot. (***Note***: The technical committee will not provide projector, screen or other presentation equipment.)
4. Team members should design, build, and experiment with robots constructed for the SkillsUSA Urban Search and Rescue Challenge. Other approved parts and raw materials may also be used. The prebuilt robot and arm mechanism will be required to grab, hold and move objects during the mission.
5. The robot's arm mechanism must be capable of opening a standard-size mailbox and reaching *into the box up to five inches*, grabbing the simulated ordnance, and pulling it out of the mailbox. The arm mechanism must be capable of reaching items positioned *up to nine inches above the floor*
6. Part Restrictions:
    a. Limit of eight total motors in any combination of DC, and/or servo-type motors.
    b. Maximum of one remote control transmitting system.
    c. One rechargeable battery pack to power the robot's mechanical functions. Maximum voltage should not exceed manufacturing specs of 12.8 V. Other energy storage devices are not allowed, e.g., capacitors.
    d. Robot battery pack must be securely fastened to the robot's chassis away from sharp edges, corners, screws, and moving parts.
    e. Robot must fit into an 18" x 18" x 18" space when starting but may be expanded to a larger size during the challenge.
    f. Any other battery-operated components installed on the robot must use one of the above-listed power sources.
7. Each team must provide in its engineering notebook a technical drawing or blueprint detailing the construction of its robot drive chassis and additional drawings/blueprints for its associated arm mechanism.
8. The robot and arm mechanism must be assembled by the team prior to the competition.
9. All robots will be required to pass inspection by judges to determine if all of the parts used are from the list of allowed parts.
10. Robots will not be allowed to compete with an arm mechanism that poses danger to competitors or could potentially cause damage to the challenge field.
11. Robot wiring must be secured to chassis free and clear of any moving parts to avoid entanglement while competing.

12. Team members will be required to follow proper safety procedures and use eye protection at all times in the competition area.
13. Teams may bring a laptop computer and blueprint drawings of their robot and arm mechanism designs to the competition building area. A description of the assembly process is required to be within the Engineering Notebook. The designs also may be printed or hand-drawn copies.

Engineering Notebook

The Engineering Notebook will be submitted for judging at check-in. Required elements include:

1. Overall neat and professional appearance
2. A complete bill of materials for the robot drive chassis and arm mechanism designed and used in competition at the event
3. A detailed description of the assembly process for the robot drive chassis and arm mechanism
4. Illustrations, sketches, photos, and written log entries accurately documenting the design and prototyping iterations detailing the evolution and logical progression of the robot's design
5. Explanations noting how testing was conducted, why modifications were made, skills learned, and how robot might further be modified to improve performance and achieve desired objectives if no restrictions were in place

Challenge Course Rules

***Note*:** Team members must wear safety glasses at all times while they are in the competition area! All teams will be expected to adhere to the official rules for the Urban Search and Rescue Challenge competition and compete in a positive and professional manner.

1. At the competition event, all teams must complete the five standardized skills trials prior to the simulated search and rescue mission in accordance with the event schedule.
2. Teams will demonstrate proficiency in the following five standardized skill trials:
    a. Arm mechanism trial – open three mailboxes and remove ordnances. Each mailbox will progress in difficulty. For example, each mailbox might be taller than the next; the specifications won't exceed those noted in the Competition Guidelines above.
    b. Navigation trial – pick up and maintain control of an ordnance while driving to specified disposal areas of the field.
    c. Drive chassis trial – traverse various terrains and multilevel obstacles. For example, obstacles may include ramps, teeter-totters, and simulated debris.
    d. Camera POV trial – navigate the robot through an obstacle using only a camera in first-person point of view without the help of a spotter, approach an ordnance, and pick it up. Examples of the obstacle could be a tunnel or the interior of a house.
    e. Communication and collaboration trial – navigate the robot through a specified course without the assistance of a camera and using direction and information from a spotter only.
3. For the simulated urban search and rescue mission, a total of two ordnances will be placed. One of the ordnances will be placed in a specified location. The other ordnance will be placed in a random location determined by the event chairperson. The random location will likely change from one run to the next. For the known ordnance location, there will be two obvious routes. One route will be higher risk but with potential time savings. The other route will be lower risk but could potentially take longer. These routes will be determined by the

event chairperson. Teams should strategize when determining their route to the known ordnance.

4. At the competition site, the skills trial fields and simulated urban search and rescue field will be provided and maintained by the technical committee. During competition, the fields will be reset to their original state before each team competes. The ordnance pieces will be placed before each team competes.
5. Each team will operate its mobile robot and navigate by first-person POV through the video feed from an onboard wireless camera. The command center will be within view of the playing field. The designated driver must remain seated at the command center while the designated spotter remains in the defined spotting area while competing.
6. An official will supervise the placement of each team's robot at the starting point on the challenge field. (Reminder: The robot must fit within an 18" x 18" x 18" space at the start but may expand to any size after it enters the field.)
7. After a "clear" signal is issued by a challenge course official, time will begin as soon as the robot moves. Time will stop following successful completion of a trial or mission upon return to home base before the time limit expires.
8. Time limits for completing each skill trial are as follows: (Estimates: the times and number of trials may change based on the number of teams entered in the event.)
    a. Arm mechanism trial – 3 minutes
    b. Navigation trial – 3 minutes
    c. Drive chassis trial – 3 minutes
    d. Camera POV trial – 2 minutes
    e. Communication and collaboration trial – 2 minutes
9. The simulated urban search and rescue mission will last a maximum of 6 minutes.
10. Team members are not allowed to touch their robot at any time while a trial or mission is in progress, unless instructed to do so by a judge.
11. For the urban search and rescue mission, the containment unit where the ordnance pieces are placed by the robot after removal from the course must remain outside the field of play and as close to the starting position as possible.
12. Points will be awarded for the skills trials and urban search and rescue mission based on the official competition rubrics.

Penalties

1. A deduction will be assessed each time an ordnance is dropped.
2. Each time the robot stalls or becomes hung up and must be freed by officials, a deduction will be assessed. An official will free a robot at the request of a team member.
3. A deduction will be assessed whenever a robot goes off the designated path within the neighborhood or outside of the course boundaries. Shortcuts are not allowed.

APPROVED MATERIALS

Approved robot materials and quantity to be used:

Urban Search and Rescue Challenge Bill of Materials

4" wheel	6
16T sprocket	4
24T Sprocket	6
32T Sprocket	2
Chain w/Link	1
Chain Breaker	1
Gear Hub Spacer	10
100 mm Axle	12
DC Drive Motor	2
Motor Mount	2
Axle Set Collar	12
288 mm Channel	6
160 mm Channel	4
96 mm Channel	4
32 mm Channel	6
L Bracket	6
Flat Building Plate	2
Flat Bracket	6
2" Standoff Post	12
1" Standoff Post	12
180 Servo	2
Single Servo Bracket	2
180 Servo Bronze Bushing	24
Axle Hub	12
Motor Hub	2
$^1/_8$" Axle Spacer	24
$^3/_8$" Axle Spacer	6
Motor Power Cable	2
On/Off Switch	1
12-volt Battery	1
Motor Speed Controller	1
$^1/_2$ SHCS	200
Hex Keys	1
Zip Tie Pack	20
Kep Nut	200
$^3/_8$" BHCS	50
NiMH Battery Charger	1
4ch R/C Controller	1
288 mm Flat Bar	4
Servo Pivot w/Bearing	1
80T Gear	2
40T Gear	2

Electronics Deck	1
Green Bin	1
Lid	1
Top Card	1
Side Label Sticker	1

Camera Pack

900 MHz Camera	1
9-volt Adaptor	1
Camera Mount	1

Control System

2.4 GHz 6ch R/C Controller	1

ADDITIONAL PARTS AND RAW MATERIALS LEGAL FOR USE:

1. Other robot parts similar in size and design to Urban Search and Rescue Challenge materials
2. One 12" x 24" sheet of acrylic plastic, maximum thickness of 0.250"
3. One 12" x 24" sheet of aluminum, maximum thickness of .080"
4. 3-D-printed parts of original design
5. Raw material used for fabricating custom robot part

STANDARDS AND COMPETENCIES

RR 1.0 — Demonstrate knowledge in safety rules and practices

1.1. Maintain a safe work area
1.2. Demonstrate safe and correct use of hand tools
1.3. Follow safety rules during robotic assembly
1.4. Demonstrate safe operation of robotic equipment in teleop mode

RR 2.0 — Produce technical documentation

2.1. Keep an engineering notebook detailing design discussions, design details, design changes and troubleshooting notes
2.2. Develop a technical drawing of the final competitive robot design
2.3. Produce a bill of materials for the final competitive robot design
2.4. Explain design choices and changes made within the engineering design process

RR 3.0 — Demonstrate knowledge of robot parts

3.1. Identify mechanical and electrical parts of the final robot design
3.2. Demonstrate understanding of the mechanical and electrical functions of the parts of the final robot design

RR 4.0 — Demonstrate understanding of robot mechanical systems

4.1. Identify mechanical systems within the final robot design
4.2. Demonstrate the function of control systems of the final robot design
4.3. Demonstrate and explain the functioning of the drivetrain of the robot
4.4. Demonstrate and explain the functioning of the package delivery system of the robot

RR 5.0 — Demonstrate understanding of robot electrical systems

5.1. Identify electrical/electronic systems within the final robot design
5.2. Demonstrate and explain the function of electrical control systems of the final robot design

RR 6.0 — Demonstrate teleop skills and real-time problem solving

6.1. Demonstrate ability to maneuver the robot safely and quickly through rough and unknown terrain via teleop
6.2. Demonstrate ability to overcome challenging areas of course terrain via teleop
6.3. Demonstrate ability to locate objects through remote robotic manipulation via teleop
6.4. Demonstrate ability to transport objects via teleop

RR 7.0 — Demonstrate ability to present and explain technical information

7.1. Demonstrate correct and effective use of oral, written and technological tools to present technical information regarding engineering design process, robot construction and robotic teleop control
7.2. Demonstrate knowledge of design choices and implementations during the engineering design process
7.3. Demonstrate knowledge of team processes and individual team member contributions

RR 8.0 — 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 above, as you may be scored on specific elements applied to your project. For more, visit: www.skillsusa.org/about/skillsusa-framework/.

COMMITTEE IDENTIFIED ACADEMIC SKILLS

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

Math Skills

- Use scientific notation
- Use fractions in contextual applications to solve problems
- Students use percentages in contextual applications to solve problems.
- Students solve problems through the contextual application of proportions.
- Students measure time, distance, and angles within contextual problem-solving applications.
- Students simplify numeric expressions.
- Students use comparisons, predictions, and inferences in analyzing data to solve a problem.
- Students use modeling techniques to solve problems.
- Students write and solve algebraic expressions in one or more variables.
- Students use derived measurements to solve problems.

Science Skills

- Plan and conduct a scientific investigation
- Apply knowledge of heat, sound, mechanical, chemical, electrical and light energy within contextual problem-solving applications
- Apply knowledge of kinetic and potential energy in contextual applications to solve problems
- Use knowledge of Newton's laws of motion
- Use knowledge of simple and compound machines to solve problems
- Apply knowledge of gears, motors and linkages to solve problems within contextual applications
- Use formulas to solve problems
- Apply scientific knowledge within the engineering design process
- Apply knowledge of force and motion concepts in contextual problem solving
- Use knowledge of mechanical, chemical and electrical energy
- Use knowledge of temperature scales, heat and heat transfer
- Use knowledge of work, force, mechanical advantage, efficiency and power
- Use knowledge of principles of electricity and magnetism
- Use knowledge of static electricity, current electricity and circuits
- Use knowledge of signal frequencies and baud rate
- Use knowledge of communication modes (full/half duplex)

Engineering Skills

- Apply the engineering design process to solve a contextual problem
- Apply the principles of circuit analysis
- Apply the elements of circuit design and construction
- Understand and apply energy and power types, sources, and conversions
- Apply methods of maintaining, servicing, troubleshooting and repairing systems
- Apply skills and techniques related to building, repairing, and maintaining robotic mechanisms
- Apply techniques and technologies related to the production of technical drawings
- Apply basic mechanical skills related to robotic design, construction, and troubleshooting
- Understand and apply knowledge of safety during construction and use of equipment
- Apply problem-solving and engineering-design processes to solve unforeseen challenges

Language Arts Skills

- Make effective use of spoken, written, and visual communications with team members within the problem-solving and engineering-design processes
- Make effective use of spoken, written, and visual communications with a variety of audiences
- Use appropriate information resources within the research-and-design process
- Organize and synthesize information for use in research-and-design processes and in written and oral presentations
- Demonstrate the ability to correctly read and interpret rules, instructions, and specifications within the robotic challenge
- Demonstrate the proper use of language, both written and verbal
- Demonstrate knowledge of appropriate reference materials

CONNECTIONS TO NATIONAL STANDARDS

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

Math Standards

- Algebra
- Data analysis and probability
- Problem solving
- Reasoning and proof
- Communication
- Connections
- Representation

Source: *NCTM Principles and Standards for School Mathematics. For more information, visit: www.nctm.org.*

Science Standards

- Understands relationships among organisms and their physical environment
- 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.*

Language Arts Standards

- 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, and 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 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.*