Official Competition Rules

October 24th, 2018

Table of Contents

General Competition Rules

1. A single school can bring as many teams as they have interested students
2. Teams may consist of 1 to 4 students, but no more than 4

Aerospace Engineering Competition

Tour Plane Design

You work for an aerospace company that is competing for a bid to design an airplane for a tour company. This company carries tourists to visit the natural wonders of the world. Many of these wonders are in harsh terrains with questionable weather patterns, and there are generally only very short, narrow, and poorly maintained runways at these locations. There will be two parts to this competition: a presentation component and a flight component. For the presentation, you must argue why your plane is the best one for the job within a 5-minute time limit with the use of visual aids. For the flight component of the competition, you must build a rubber band powered aircraft that can clear an 18-inch-tall obstacle with a runway length of 12 feet. Since the runways will be narrow, the planes with the shortest wingspan will have the best chance at winning the bid. To make the aircraft more robust for the tough runway conditions, there will be different runway conditions you will encounter:

- ➔ Sand condition: a light layer of sand will cover the runway with a depth of approximately ⅛ inch
- ➔ Pebble condition: one layer of small pebbles no more than ⅛ inch in diameter will be placed on the runway
- ➔ Log condition: standard #2 pencils will be placed perpendicular to the runway at approximately 6-inch intervals

*Note: Each of these hazards will not be attached in any way to the runway

You will get three (3) opportunities to take off. The runway condition can be changed between attempts. The highest score from the three attempts will be taken.

Once you are in the air, you will need to make sure you stay in one piece, so a wing tip loading structural analysis test will be performed to ensure the plane can fly in the harshest weather conditions. A line will be attached to each wingtip, and an upwards force from a simple spring scale will be tested until wing failure. “Failure” is defined as the inability to fly. A load will be applied until an audible cracking sound is heard. At that point, the load will be recorded and then released. The team will have the option to attempt flight. If the plane can take off completely, the loading will continue until the next audible cracking sound; however, if the plane cannot take flight, the wings will be considered to have “failed”. The max force recorded will be the max wingtip loading capacity. You can use a plane from a kit; however, it is recommended that this plane be modified so that the score can be maximized. Teams can have up to 4 members. One backup plane is allowed and can be switched between flight attempts; however, the plane that obtains the highest flight score will be the one that will undergo the wing tip loading test.

See next page for scoring criteria:

Scoring:

- ➔ Presentation score: The presentation will be scored by a panel of judges on a scale from 0-10 on how well the team can persuade the judges to select that plane for the bid
- ➔ Flight score = (Leave ground) * (Clear obstacle) * (Max wingtip loading capacity) *(Runway Condition) / (wingspan * weight)
- ➔ Leave ground: 1 point if plane entirely left the ground or 0 if it did not
- ➔ Clear obstacle: 5 points if plane cleared the obstacle or 1 if it did not
- ➔ Max wingtip loading capacity: Max recorded force from wingtip structural analysis test (in lbs.) ("failure" is considered "non-flyable" or when "first audible sounds occur")
- ➔ Runway Condition: 1 point for sand runway, 2 points for pebble runway, 3 points for runway with log
- ➔ Wingspan: Longest horizontal aircraft span (in inches)
- ➔ Weight: Weight of aircraft (in oz.)

- ➔ **Total score = (Presentation score) * (Flight score)**

Rule Clarifications:

- ➔ The runway width is 4 ft
- ➔ The 18 in barrier will be at the end of the runway as well as along the sides
- ➔ The airplane must take off from the ground
- ➔ There cannot be any externally powered takeoff
  - ◆ There cannot be any structure left behind on the runway
  - ◆ The rubber band to power the aircraft must be used internally
- ➔ In the wingtip loading test, if no audible sounds are heard after 20 lbs are applied, the aircraft will be tested for flight and continue to be tested at 20 lb increments
- ➔ The maximum wingtip loading capacity will be 60 lbs

Bioengineering Competition

Mechanical Leg

The Seven Wonders of the world have been iconic spectacles of humankind's engineering brilliance for years. Now, they are tools we can use to test a generation of young engineering students in their journey to develop new wonders in an advancing world. Using the Seven Wonders of the Ancient World, you and your group will create a Seven Wonders-inspired team name and a mechanical leg to compete and outscore the competition in a limited time interval. Each Wonder will serve as a goal (sitting side by side in a row of seven) and will earn you a specific amount of points, exponentially increasing from 5 to 20 points from the center to the outside goals (also decreasing in size). Your mechanical leg must have the strength and ability to continuously kick size 1 (205-gram, 18-20 in circumference) mini soccer balls a distance of 15 feet. The leg must also be able to rotate on axis, as you will not be able to move it from the starting point (center of the goals). The time allotted to you will be 1 minute and 30 seconds, so make sure the leg can be reloaded easily and quickly. Teams may consist of 1-4 students. There is also a chance to score bonus points for teams who achieve more points than the score limit in the time given!

Game Setup:

- ➔ Device will be placed 15 feet from center goal
- ➔ The center goal will be 14 inches in width and 12 inches in height. Each goal extending from the center will decrease by 2 inches in width (height stays at 12 inches) from the previous neighboring goal (center- 14 in, one from center- 12 in, two from center- 10 in, and three from center- 8 in)
- ➔ Each goal will be separated by 2 inches

Building Specs:

- ➔ No limit to size of device
- ➔ Must have some form of kicking ability, participants will be allowed to re-adjust the angle and reload the device for each kick, but it cannot be swung down manually (examples for kicking ability: spring-loaded, swing with a release, etc.)
    - ◆ The device is also not allowed to be move from the original spot
- ➔ Display team name on the device
- ➔ Any material can be used to create the device, but a document describing how and where each material is utilized must be presented (also include a bill of materials)
    - ◆ Adding on to this, although you are allowed to use any material and mechanism to create your device, you must be creative. Use your engineering intellect and skill to create the device with even the most basic of materials. Avoid just buying your way through the construction. (Large portion of points comes from creativity)
- ➔ No weight limit for the device
- ➔ Device must be stabilized on its own
- ➔ Ensure that the leg can rotate at least 60 degrees from the center in both directions (in order to aim at different goals)

See next page for presentation details and scoring rubric:

Presentation:

- ➔ Points will be given for a presentation of the designed device. Students will be expected to provide a quality visual aid for their design (posters and PowerPoints are acceptable formats, a projector will be provided), including images and a description of their design process. This design process will also be a major component of points awarded in this category, which includes evidence of research, brainstorming, creativity, prototypes, and an explanation for their thought and design process throughout the various stages of the project.

Scoring Rubric:

Design Ingenuity:

- ➔ Use of Materials: _____/ 10
- ➔ Functionality: _____/ 10

Presentation:

- ➔ Visual Aid: _____/ 10
- ➔ Presentation Performance: _____/ 10
- ➔ Team Understanding: _____/ 10
- ➔ Design Process: _____/ 10

Game: _____/ 40

- ➔ Bonus Points: _____/ 10

Sum of points earned is total score (out of 100)

Chemical Engineering Competition

Chemical Chariot

Thousands of tourists come each year to visit the Seven Wonders of the World. It is your job to create the fastest and most luxurious chemical chariot to allow them to get from the airport to the wonder. Some of the sites are far from the airport, so extra distance will be worth extra points. When tourists get off the plane, they want to reach their destination as fast as possible, so the fastest chariots will be awarded extra points. Finally, the design and appearance of the chariot will also be graded, and creative designs will be awarded extra points.

Objective/pre-submission:

The chariot must be operated by a non-combustible reaction that travels at least 10 feet. This reaction can be carried out 3 times (each on a separate run), so make sure the chariot is reusable and the students are prepared to operate it. Only the best of the 3 runs will be counted toward the final score. Extra points will be awarded if the chariot travels longer than 10 feet and points will be deducted if it travels less. One week prior to the competition day there must be a document submitted via email to highschooldesign@ku.edu that includes how the chariot works and why the reaction was chosen. **Students may use any chemical reaction to power their vehicle so long as it does not put any students at risk of physical or chemical harm.** Competitors must launch the chariot without the addition of any external physical force (i.e. they cannot push the chariot forward). This portion of the competition will be worth 30 points.

Competition Day:

There will be points based on how fast the chariot travels the 10 feet. This will be out of 20 points. We will start with a basis of a 10-15 seconds being rewarded a full 20 points. This may be altered based on the rest of the competitors on the day of the competition. The best of the three attempts will be judged.

Judging:

A panel of students, volunteers, and industry professionals will be judging the chariots based on aesthetics as well. This portion is worth 10 points but extra points may be collected if the chariot far surpasses its competitors. This will be scored based on the design and creativity of the chariot. Points will be deducted if it is found that the vehicle was made using a pre-made kit, and may be grounds for disqualification.

Final Score:

Distance	<5 feet 10 points	5-9 feet 20 points	10 feet 30 points	>10 feet Extra points
Speed	>20 seconds 10 points	15-20 seconds 15 points	10-15 seconds 20 points	<10 seconds Extra points
Aesthetic	Based on competition			

*Distance and speed will be judged based on single best attempt.

Civil Engineering Competition

Bridge Consulting

Lawrence needs a new bridge, and it's up to your engineering firm to design it! The city leaders who hired you for the project want you to look at other bridges around the world for inspiration and report to them about one of them. You do not have to make your design like the global bridge you report on, but you do have to discuss one in your presentation. Your presentation should also include a team introduction, your AutoCAD drawings, pictures of your bridge, and a brief explanation of the process of designing the bridge. Additionally, make sure everyone on the team has a part in the presentation. Each team can have up to 4 members.

The competition has three parts: Presentation, Drawings, and Load & Cost. The competition rules are listed below, followed by the scoring criteria for each part:

Rules:

1. Bridge Height and Span Length Requirements
   - ➔ Minimum height for boat clearance: 1.5 feet
   - ➔ Maximum height: 3 feet
   - ➔ Maximum width: 8 inches
   - ➔ Minimum central span length between the two supports: 3 feet
   - ➔ Maximum central span length between the two supports: 4 feet
   - ➔ Minimum overall deck span (from end to end): 5 feet
   - ➔ Maximum overall deck span (from end to end) 6.5 feet
   - ➔ Minimum overhang on either side of supports: 3 inches
   - ➔ Ensure that the bridge deck is one consistent height so cars can drive across the road and has two supports
   - ➔ NO adhesives will be allowed in the structure, only approved K'Nex pieces

2. Approved K'Nex Pieces
   - ➔ Standard gray rod (7 and ½ inches)
   - ➔ Standard red rod (5 and ⅛ inches)
   - ➔ Standard yellow rod (3 and 7/16 inches)
   - ➔ Standard blue rod (2 and ¼ inches)
   - ➔ Standard dark gray connection
   - ➔ Standard red connection
   - ➔ Standard blue connection
   - ➔ Standard white connection
   - ➔ *If the color is different but the size is the same as these standard pieces, the piece will still be acceptable. Length and standard type are the main considerations.*
   - ➔ *Pieces must be from standard K'Nex set (not Flexible/Micro sets, etc.)*

3. Bridge must be able to withstand initial load (1 lb.) attached in the middle of the bridge. This load will be attached to a rod with a rope, so leave an easily accessible rod for the rope to be attached.
4. Team presentation cannot exceed 4 minutes including World Wonders portion. The team will be cut off at exactly 4 minutes even if the presentation is not finished.
5. The competitors must email all materials (plan sheet with drawings, pictures, and cost analysis) except the pitch to highschooldesign@ku.edu by *Sunday, October 21 at 11:59 pm*. Be sure to include the name of your team with the submitted materials.
6. The School of Engineering is not responsible for bridges damaged during transport. Each team will have up to 1 hour to fix/construct the bridge before the load is added the day of the competition; for this reason, teams are encouraged to bring the bridge in sections so construction is quick and simple. The School of Engineering has a limited number of replacement pieces in case one breaks, but teams can also bring replacements as long as the actual bridge design is not altered from the design drawings on competition day.

See the following pages for scoring criteria:

1. **Presentation:** short presentation in front of the judges regarding their bridge. The total time of the presentation, including the world wonders portion, must be less than 4 minutes. This presentation should include their AutoCAD/manual drawings, current pictures of the bridge from the same angles as the drawings, the planning process, and why their bridge design will be able to carry the 1 lb. load. Additionally, present for about a minute about the design strengths of one of five "world wonder" bridges:

Christopher S. Bond Bridge (KCMO)
Golden Gate Bridge (San Francisco, CA)
Sydney Harbor Bridge (Australia)
Armando Emilio Guebuza Bridge (Mozambique)
London Bridge (UK) (not the Tower Bridge)

	Beginner 2 points	**Developing 4 points**	**Acceptable 6 points**	**Effective 8 points**	**Excellent 10 points**
World Wonder Presentation	No mention of the world wonder bridge	Bridge is not named OR there is no mention of its design strengths	Bridge is named, no specific design strengths are mentioned	Bridge is named, design strengths are well explained	Bridge is named, design strengths are thoroughly explained
Presentation Skills	No eye contact, no team introduction, too quiet to hear, negative body language	Minimal eye contact, barely/no team intro, barely audible presentation	Some eye contact, good intro, good voice projection	Good eye contact, intro, and projection; even distribution of speaking parts	Captivating presentation; great eye contact, voice volume; all members present equally
	Beginner 1 point	**Developing 2 points**	**Acceptable 3 points**	**Effective 4 points**	**Excellent 5 points**
Knowledge and Enthusiasm	No explanation of design process, knowledge about bridge, or enthusiasm, no bridge pictures.	Vague description of design process, little knowledge about bridge, not much enthusiasm, no bridge pictures	Some explanation of design process, some knowledge about bridge, some enthusiasm, no bridge pictures	Good explanation and knowledge about their bridge; mostly enthusiastic, includes pictures of bridge	Explains the design process, knowledgeable and enthusiastic about bridge, includes pictures of bridge

-*Worth 25/100 points*

(Continued on next page)

2. **Top, Side, and 3D Drawing:** side, top, and 3D model of bridge. Use the AutoCAD application or a *neat, detailed* hand sketch in pen for your drawings. Side and top models are 5 points each, the 3D model is 15 points. *The drawings must be exactly the same as the bridge on competition day.*

	Beginner 1 point	**Developing 2 points**	**Acceptable 3 points**	**Effective 4 points**	**Excellent 5 points**
Top View	No drawing submitted	Drawing is very messy, not professional, and inaccurate to actual bridge	Drawing is messy but represents actual bridge design	Drawing is accurate and mostly professional, but still a little messy	Drawing is accurate, professional, neat, and detailed
Side View	No drawing submitted	Drawing is very messy, not professional, and inaccurate to actual bridge	Drawing is messy but represents actual bridge design	Drawing is accurate and mostly professional, but still a little messy	Drawing is accurate, professional, neat, and detailed
	Beginner 3 points	**Developing 6 points**	**Acceptable 9 points**	**Effective 12 points**	**Excellent 15 points**
3D Model	No drawing submitted	Drawing is very messy, not professional, and inaccurate to actual bridge; difficult to differentiate between pieces	Drawing is messy but represents actual bridge design; possible to differentiate between pieces	Drawing is accurate and mostly professional, but still a little messy; can differentiate between pieces	Drawing is accurate, professional, neat, and detailed; different pieces easily identifiable

-*Worth 25/100 points*

(Continued on next page)

3. **Load & Cost-to-Load Ratio:** If the bridge withstands the initial 1 lb. load, more is added slowly until it breaks. If the bridge does not withstand the initial load, it is disqualified. Each K'Nex piece "costs" a certain amount. Based on this, the cost will be calculated. A cost-to-load ratio will be calculated and compared to the other bridges, and the groups with the lowest ratios will get the most points.

How to get total cost of bridge:

- ➔ (Total number of rods) x ($5) = Rod cost
- ➔ (Total number of connections) x ($3) = Connection cost
- ➔ (Rod cost) + (Connection cost) = **Total cost**

Cost/Weight Percentile Range	Points Awarded
0-10%	5
10-20%	10
20-30%	15
30-40%	20
40-50%	25
50-60%	30
60-70%	35
70-80%	40
80-90%	45
90-100%	50

-*Worth 50/100 points*

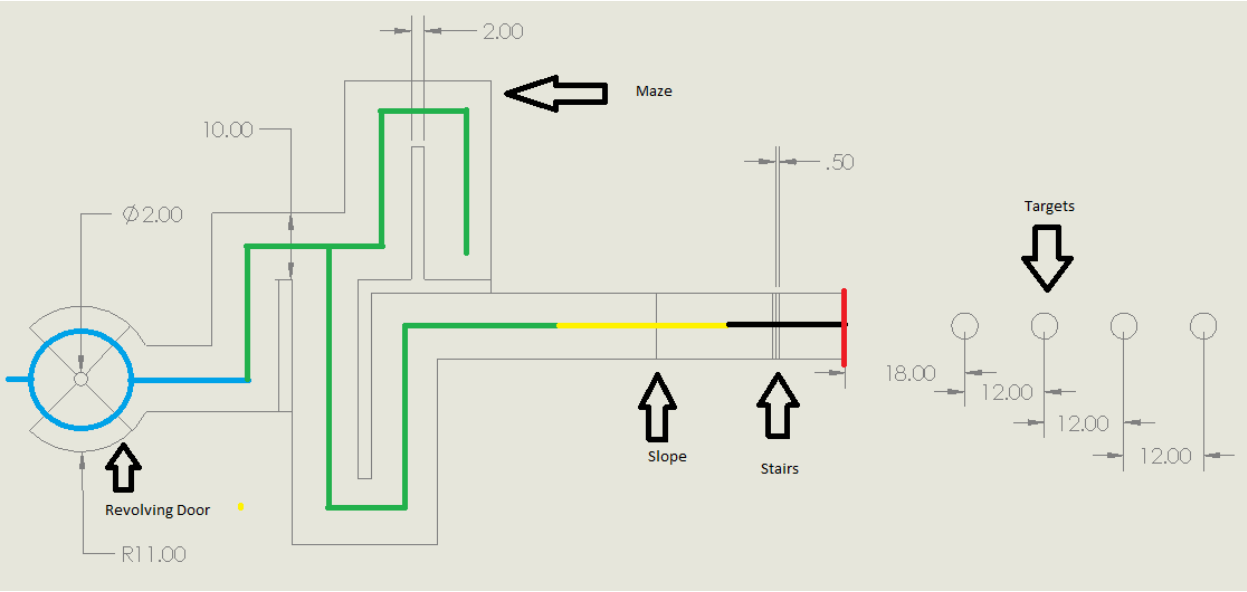
Mechanical Engineering Competition

LEGO Mindstorms

Description:

Robotics has been at the forefront of the minds of young engineers since the field's inception. Robotics lies at the intersection of mechanical engineering and computer science. Mechanical engineers must describe a machine's motion and design how it will interact with its environment so that computer scientists can then program it to accomplish these tasks. Every day, new robots are being created to solve new problems and overcome obstacles that we previously thought were insurmountable. In the University of Kansas' 2018 Mindstorms competition, students will design and program a Mindstorms robot to move through a themed obstacle course as efficiently and effectively as possible. There will be progressively more challenging obstacles in the course and upon completion of each of them, the team will receive points for their problem-solving skills. At the end of the course, there will be a challenge that will also reward points based on accuracy and precision of the robot. This final challenge will not be an all-or-nothing system like the obstacles. This challenge is meant to determine which robot is the most efficient and best optimized to solve the challenge. Teams will receive dimensions and specifications of the entire course. Teams will be given multiple attempts and their best attempt will be counted towards their final score and ranking. Teams are expected to build their robots before the competition and have a working code before their first run. This will allow teams time to tweak and improve their code or body of their bot as they encounter problems during the day.

Course Specifications



*Course is drawn to scale. All measurements are in inches. The color used in the drawing will be the color of tape used in that area of the track. The walls are at least 3.5 inches tall.

See next page for competition rules:

Rules:

1. Teams will be placed in a random queue upon arrival.
2. Teams will be called to attempt the course using this queue.
3. Teams may choose to not attempt the course when called, but they will be moved to the bottom of the queue.
4. During the attempt, the robot must show progress or forward motion through the track or the attempt will end and the points for the attempt counted.
5. Every time an obstacle is completed during an attempt of the course the team will receive a set amount of points according to the difficulty of the obstacle.
6. If an NXT can not progress past an obstacle, the team may choose to skip that obstacle; however, they will automatically lose 25 points.
7. The points for the obstacles are as follows:
    - Obstacle 1: 100
        - Robot must navigate through a revolving door. The door will just be on an axel, and it will not be in motion without the robot moving it.
    - Obstacle 2: 100
        - Robot must navigate through a maze of only right angle turns.
    - Obstacle 3: 100
        - The Robot must climb a slope at a 30 degree incline. At the top of the slope will be a sharp angle and then a downward slope at the same angle as the upward slope.
    - Obstacle 4: 150
        - The robot must ascend a short staircase of 3 steps. The steps will be half inch by half inch squares.
8. At the end of the course, every target hit by the robot will provide 25, 50, 75, or 100 points depending on the distance of the target. Points will be capped at 250 points for the accuracy challenge. Teams will be allowed to aim the robot, but it must remain 1.5 feet away from the nearest target. The robot must fire the projectile on its own.
9. If a team receives all the possible points in an attempt then the attempt will end.
10. Only the score from the best attempt will be counted towards a team's final score. (There is no chance to lose points on a second or third attempt.)
11. Teams will be given an equal amount of attempts.
12. In the event of a tie, the robot that weighs less will win the tie. The lighter robot accomplished the same tasks with less weight and is therefore more efficient.
13. Every challenge will have a unique color of tape that runs through the center of the course in that area. For the accuracy challenge, there will just be a red line that runs perpendicular to the track.

Robot Parameters

To keep this challenge as competitive and open to as many schools as possible, all teams must only use parts from a LEGO Mindstorms kit. If representatives from the School of Engineering notice extra parts that are clearly not from the kit, then that team will lose 50 points off any attempt they make unless they remove the parts and replace them with allowed parts. *IF a team is unable to comply with these regulations, have your educator contact us and we will work with you to make sure the competition remains fair and competitive and still allow you to compete.*

Computer Science Competition

Programming

Each student team, consisting of 1-4 students, will be given several problems of varying difficulty and point values. You will be allotted three hours to compete for as many points as possible. Teams will be able to select which problems they tackle and in what order they choose to do so in order to accumulate the most points possible. In the case of ties, collective time (as marked in seconds, running from the beginning of the competition) will be used as a tiebreaker. Therefore, teams should strategically pick which questions to work on first according to their comfort level.

All programming will be done via the use of a web browser, ensuring a level playing field. Teams will not be allowed to access any outside information during the competition including internet resources and printed materials. The primary focus of the problems will test the principles of programming logic and algorithmic thinking.

Students could expect to see topics such as but not limited to:

- ➔ for-loops
- ➔ while-loops
- ➔ if/else statements
- ➔ input/output

Some advanced problems might dive deeper into topics such as data structures, and sorting algorithms.

Here are some resources that could help you prepare for the competition. Keep in mind that the best way to learn is by finding examples to work on.

- ➔ CodeAcademy
- ➔ Euler Project
- ➔ Stackoverflow
- ➔ Treehouse (paid)
- ➔ Udacity (paid)

Because we have an automated judging system, we recommend that you use one of these three supported programming languages:

- ➔ Java
- ➔ Python
- ➔ C++

If you have any questions, feel free to reach out. We look forward to seeing you on campus!