MESA DAY CONTEST RULES 2018 – 2019

(Version 8.1.18)

Prosthetic Arm

LEVEL: Grades 9/10 and 11/12

TYPE OF CONTEST: Team

COMPOSITION OF TEAM: 2-3 students per team

NUMBER OF STUDENTS: Preliminary – As determined by your local MESA Center
Regional – 1 for 9th/10th Grade; 1 for 11th/12th Grade per Center

SPONSOR: Ben Louie, Associate Director, USC MSP
Cathy Douglas, Associate Director, UCLA MSP

OVERVIEW: Students will design, construct, and operate a simulated prosthetic arm that can grab, stack, and release plastic cups into a pyramid in the fastest time. **Participation logistics, limits, and competition facilities may vary by host site. Advisors and students are responsible for verifying this information with their center director.**

An Engineering Lab Book is a required component of this competition. The purpose of the Engineering Lab Book is for students to closely follow the practices of an engineer in the completion of their MESA Day project. The Engineering Lab Book will encourage students to take a purposeful and sustained approached to building their devices. MESA projects are not designed to be completed in a single class period or day, but to be the result of thoughtful research, planning, analysis and evaluation. The lab book should provide a written record of the thought and insight that a student put into their project, from initial ideas to the final completed project.

MATERIALS: For the device, all materials are legal with the exception of hazardous materials. There are no cost limitations; however, awards will be given to the most innovative designs utilizing low-cost materials.

For the Engineering Lab Book, there are three format options for lab book submittals: Electronic Lab Book, Printed/Written Pages or Standard Lab Book. Please check with your local center director for the format required for your preliminary event. Electronic submissions will be required at the Regional/State level.

The Host Center will provide the following:

- 21 – Red Solo Cups 16 ounce plastic cold cups from Amazon or equivalent

GENERAL RULES:

1) The students' full name, school name, grade and MESA Center must be clearly labeled on the device. A 10% penalty in the score will be assessed for failing to properly label.
2) The device must have at least two artificial fingers. These fingers:
    a. MUST open and close. At least two fingers are required to move.
    b. MUST grab, stack, and release the plastic cup into a pyramid. Team member may NOT use any other part of the prosthesis or parts of his/her own hand, wrist or arm to grab and release the plastic cup.
3) The device must NOT be controlled or operated by either of the team member's fingers, hands, or wrists.
4) In order to simulate an amputated arm, participating team member must have his/her wrist, hand, and fingers immobilized during the competition. The team will determine own method for immobilization.
5) The device (i.e. artificial fingers) may only grab, stack, and release ONE plastic cup at a time.
    a. A plastic cup that is dropped on the table or floor, knocked over, knocked off the pyramid, etc. must be grabbed by the artificial fingers before attempting to replace it onto the pyramid.
6) During the trial, the team member may use his/her encumbered hand to hold and move the original pre-stack of cups, but the bottom must remain in contact with the table at all times.
7) Lab books are meant to clearly demonstrate and illustrate evidence of the application of the Engineering Design Process in the MESA project.

    The Engineering Lab Book must be properly labeled (names, school, center, grade level, etc.) and contain and cover the following sections using the template provided:

    1. **IDENTIFY THE PROBLEM** (at least 2 sentences for each question)
       State what is the challenge being worked on? What are the limits/constraints? How do you think you can you solve it?
    2. **EXPLORE**
       Find out what others have done (research). Clearly list at least 5 sources (web pages, books, etc.). Identify (cite) and describe them.
    3. **DESIGN**
       Brainstorm ideas (at least 3 ideas) and record them. Each idea should be represented by a sketch or drawing.
        i. One sketch should be of the anatomy of the human arm and the other sketches of the device. These sketches MUST be hand-drawn or student's original computer-generated. Sketches should indicate a progression in the thinking and design of the device, and be detailed. Sketches must be no smaller than one page, and can either be drawn on the lab book page directly or attached.
        ii. The sketch of the anatomy of the human arm AND the sketches of the device should include the following eight required and correctly labeled structures:
            - Radius/Ulna
            - Flexor Carpi Ulnaris
            - Radiocarpal Joint
            - Carpus
            - Carpometacarpal Joint
            - Metacarpus

- Phalanges
- Tendons

Select one idea and create a plan (at least 5 sentences) to build a prototype from. Generate a list of materials for your prototype. Table should list all materials utilized for the above eight required structures.

Sample Materials Table

Structure	Material
Radius/Ulna	Mailing Tube
Flexor Carpi Ulnaris	Bungee cord
Radiocarpal Joint	Hinge

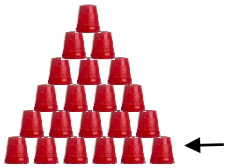
4. **CREATE**
   Using your plan, build your prototype. Include a picture of the actual project prototype.
5. **TRY IT OUT**
   Test your idea/prototype. Attempt at least 3 trials/attempts of your test. Measure the results of your test (by project performance criteria). Provide evidence of the use and application of at least 2 appropriate mathematical concepts in your tests. This section must include the calculations for <u>both</u> the following:
   - Calculate how much work is done by the artificial fingers in grabbing an object by using $W = Fd$.
   - Calculate the grab and release speed of the artificial fingers by using $d = rt$.
6. **MAKE IT BETTER**
   Describe how you can make the project better and what modifications you will be making (at least 5 ways you can improve project). Build and prepare competition ready project. Include a picture.

JUDGING:

1) Devices will be checked for specifications prior to the start of the competition. If devices are disqualified during the specification check, design changes will not be allowed.
2) Repairs are only allowed with duplicate parts and materials.
3) Each device will be allowed two (2) non-consecutive trials.
4) At the beginning of each trial, team member must demonstrate immobilization (see Rule 4).
5) Each device must be ready when called or team will forfeit that trial.
6) Each team will be given up to 60 seconds to prepare, attach, and demonstrate prosthetic arm, and to place the pre-stack of 21 plastic cups facing down anywhere on the table (i.e. the lips of the cup facing down). If at the end of the 60 seconds the team is not ready, the trial will be declared a mistrial and this process will be repeated for the second trial.
7) The judge will give the start order and begin the timer.
8) The team member will enter the *Working Area* and will have a maximum of 1 minute (60 seconds) to grab, stack, and release the plastic cups into the tallest pyramid. The judge will notify the team when 30 seconds, 20 seconds, and 10 seconds remain.
9) The judge will stop the timer when the last plastic cup has been placed onto the pyramid. Or, the judge will call "time" after one minute has passed.
   a. The judge will record the time needed to complete the trial.
   b. The judge will count the number cups successfully stacked on the second tier or higher (i.e. cups still stacked at the end of the trial).

SCORING:

1) Team points-to-time ratio = total points divided by trial time in seconds (00.00)
    a. 20 points awarded for each plastic cup on the second tier or higher; plastic cups on the first tier will NOT earn points (maximum of 15 cups x 20 = 300 points)
    b. Time needed to complete trial (maximum of 60.00 seconds)



2) Maximum of 4 points awarded for sketches and materials table
3) Final Score = best points-to-time ratio plus (+) sketches/table points
    a. The best points-to-time ratio of the two trials will be used
4) A deduction of 20% of the final score will be assessed for an incomplete Engineering Lab Book and a deduction of 50% of the final score will be assessed for a missing Engineering Lab Book.

AWARDS:

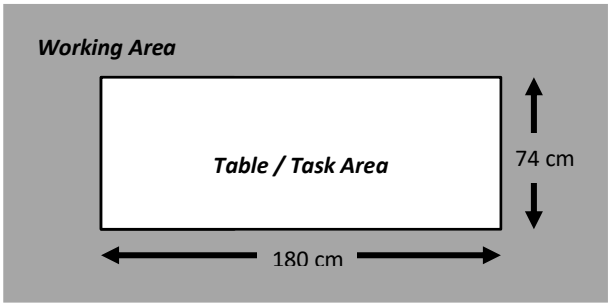
- Medals will be awarded for 1st, 2nd and 3rd place based on the greatest Grand Total Score.
- Ribbons will be awarded for Innovative Engineering Design utilizing low-cost materials.
- Only teams placing in the Grand Total Score category will advance to Regional MESA Day.

ATTACHMENTS/APPENDIX:

- Competition Area Specifications
- Equipment
- Inspection & Score Sheet for Prosthetic Arm
- Engineering Lab Book Requirement Rubric

Competition Area Specifications

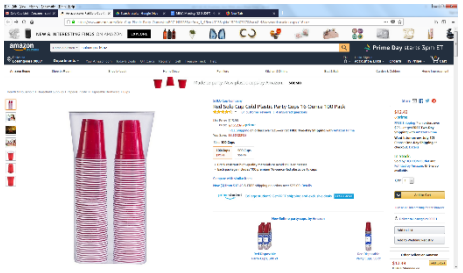
- A standard six foot table with approximate dimensions of 180 cm (L) x 74 cm (W) x 75 cm (H).



    - A perimeter of approximately one (1) meter around the table will be marked with tape. Only the team member actively participating during the trial will be permitted in this *Working Area*.

Equipment

- 21 pre-stacked Red Solo 16 ounce plastic cold cups from Amazon (Link to cups on Amazon https://goo.gl/Rw85ga) or equivalent recommend additional plastic cold cups as replacements)
- Standard six foot table
- Measuring tape
- Masking tape to outline the *Working Area*
- 1 stop watch to record trial time



INSPECTION AND SCORE SHEET FOR PROSTHETIC ARM

High School – Grades 9/10 and 11/12

Copies of this inspection and score sheet will be provided by the MESA Day Host Center.

Student Names: _____ Grade: **9/10** or **11/12** (circle one)

School: _____ MESA Center: _____

Section below to be completed by Judges

INSPECTION LIST:	**YES**	**NO**
Device includes at least two artificial fingers that open and close (at least 2 fingers are required to move)..	☐	☐
Fingers grab and release cups	☐	☐
Device not controlled by fingers, hands, or wrists of either hand	☐	☐
Team has demonstrated immobilization of the fingers, hand, and wrist	☐	☐
Device labeled properly (students' full name, school name, grade and MESA Center)	☐	☐

Innovative Engineering Design (ranking – 1, 2, 3, etc.): _____

SKETCHES AND MATERIALS TABLE

Structure	Material Listed 0.1 points	Sketch of Arm Anatomy		Sketch of Final Device		Sub Total
		Present 0.1 points	Correctly Labeled 0.1 points	Present 0.1 points	Correctly Labeled 0.1 points	
Radius/Ulna						
Flexor Carpi Ulnaris						
Radiocarpal Joint						
Carpus						
Carpometacarpal Joint						
Metacarpus						
Phalanges						
Tendons						
					TOTAL (maximum 4 points)	

TRIAL 1

# of cups: _____ x 20 = ☐ *(count ONLY cups on second tier or higher)*

Trial Time (00.00 seconds): ☐ Cup Pts/Time Ratio: _____

Mistrial (reason):

TRIAL 2

# of cups: _____ x 20 = ☐ *(count ONLY cups on second tier or higher)*

Trial Time (00.00 seconds): ☐ Cup Pts/Time Ratio: _____

Mistrial (reason):

Final Score (best of two trials + Sketches/Materials Table Points) _____

Device Labeling Penalty (10% of Final Score) - _____

Lab Book Penalty (20% or 50% of Final Score) - _____

GRAND TOTAL SCORE _____

MESA DAY 2018-2019

Lab Book Requirement Rubric *(criteria may vary by individual competition)*

Project:_____

Please use this rubric to assess lab book entries. An incomplete lab book (i.e., missing 1 to 2 specified criteria) will lead to a 20% deduction from the total project score. A missing lab book (i.e., not submitted OR missing 3 or more specified criteria) will lead to a 50% deduction from the total project score and will make team ineligible to place.

TEAM MEMBER NAMES:_____

SCHOOL:_____CENTER: _____

LEVEL (circle one): 6th 7/8th 9/10th 11/12th

Section		YES	NO
	Is the lab book properly labeled? *(Names, Grades, School, MESA Center)*		
1	Identify the Need (at least 2 sentences for each) *State what is the challenge being worked on? What are the limits/constraints? How do you think you can you solve it.*		
2	Explore *Conducting research (listing 5 cited/referenced sources), gathering materials, try using materials*		
3	Design *Brainstorming ideas (at least 3 iterations) each represented by a picture, sketch or drawing. Creating a plan for selected idea (at least 5 sentences). A list of materials for the prototype.*		
4	Create *Building a prototype. Describing the building of the prototype (at least 5 sentences). Including a final picture of the project.*		
5	Try it Out *Testing idea/prototype. Attempting at least 3 trials/attempts. Measuring each trial result (by specific performance criteria like distance traveled, time, etc.). Providing evidence of the use and application of at least 2 appropriate mathematical concepts in the tests.*		
6	Make Better *Evaluate results. List at least five ways project can be improved*		
	TOTAL		
	Lab Book Complete (mark with X)		

Is this considered an **incomplete** note book (circle one)? **NO** **YES** (-20%)

Is this considered a **missing** lab book? (circle one) **NO** **YES** (-50%)