Bioengineering

State Event

Event Summary

This event is a comprehensive skills test of the various fields of Bioengineering. Students' knowledge will be tested in both written and practical formats. The aim of this event is to challenge students' understanding and get them excited about the many applications of Bioengineering.

Dress Code

Competitors shall wear proper business attire or official HOSA uniform, or attire appropriate to the occupational area, during both rounds. Bonus points will be awarded for proper dress

General Rules

1. Competitors in this event must be active members of HOSA and in good standing.

2. Secondary and Postsecondary/Collegiate divisions are eligible to compete in this event.

3. Competitors must be familiar with and adhere to the "General Rules and Regulations of the HOSA Competitive Events Program (GRR)."

4. All competitors shall report to the site of the event at the time designated for each round of competition. At ILC, competitor's photo ID must be presented prior to ALL competition rounds.

Official References

5. All official references, including websites, are used in the development of the written test and skill rating sheets.

Design & Prototyping:
Ozel, T. (2016). *Biomedical Devices: Design, Prototyping, and Manufacturing.* (1st ed.) John Wiley and Sons Inc.

Programming for Bioengineers:
Pratap, R. (2009). *Getting Started with Matlab: A Quick Introduction for Scientists and Engineers.* (8th ed.) Oxford University Press.

Biomaterials:

Black, J. (1981). *Biological Performance of Materials: Fundamentals of Biocompatibility.* (4th ed.). CRC Press.

FDA's Biocompatibility Guidance on Use of ISO 10993-1, https://www.fda.gov/medical-devices/biocompatibility-assessment-resource-center/glossary-biocompatibility-terms#:~:text=%E2%80%9CThe%20ability%20of%20a%20device,Materials%3A%20Fundamentals%20of%20Biocompatibility.%E2%80%9D

Biostatistics:
Rosner, B. (2016). *Fundamentals of Biostatistics* (8th ed.). Cengage Learning.

Cellular and Molecular Modeling:
Wittrup, K. D., Tudor, B., Hackel, B. J., & Sarkar, C. A. (2019). *Quantitative Fundamentals of Molecular and Cellular Bioengineering.* The MIT Press.

Bioinstrumentation:
Practical Electronics for Inventors, 4th ed.

Medical Instrumentation: Application and Design, 4th ed.

Round One Test

6. **Test Instructions:** The written test will consist of 50 multiple choice items in a maximum of 60 minutes.

7. **Time Remaining Announcements:** There will be a verbal announcement when there are 30 minutes, 15 minutes, 5 minutes, and 1 minute remaining to complete the test.

8. Written Test Plan

The written test will include topics from several important fields in Bioengineering including:

- Design & Prototyping
- Programming for Bioengineers
- Biomaterials
- Biostatistics
- Cellular and Molecular Modeling
- Bioinstrumentation

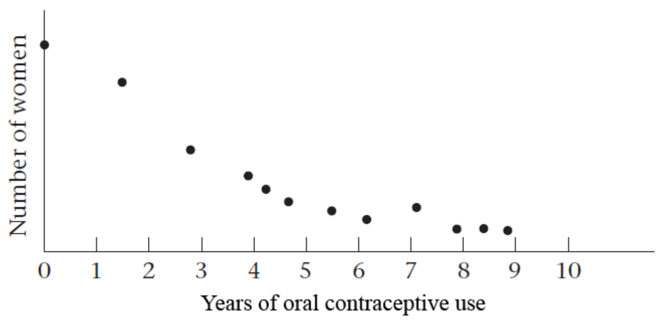
9. The test score from Round One will be used to qualify the competitor for Round Two.

10. Sample Round One Test Questions:

1). You are asked by a professor to write pseudocode for a program that parses through a long list of patient data to be analyzed. One of the initial steps in this code is to write a function that steps through each line of the list. To efficiently code this step, which statement should be called?

a.) If
b.) Else
c.) For
d.) While

2). Choose the best descriptor for the data in the following graph.



a. Positively skewed
b. Positively shifted
c. Negatively skewed
d. Negatively shifted

3). The ability of a material to perform with an appropriate host response in a specific situation would be a materials ______?

a.) Chemical Characterization

b.) Device Component
c.) Biocompatibility
d.) In vivo

Round Two Skills

11. Round Two is the performance of a selected skill(s). The Round Two skills approved for this event are:

- Skill I- Measurement of tension, stress, and strain under physiological load.
- Skill II- Performance of aseptic technique/volume transfer.
- Skill III- Measurement of solution viscosity.

12. The selected skill(s) will be presented to competitors as a written scenario at the beginning of the round. The scenario will be the same for each competitor and will include a challenging component that will require the competitor to apply critical thinking skills. A sample scenario can be found here.

13. Timing will begin when the scenario is presented to the competitor and will be stopped at the end of the time allowed.

14. The scenario is a secret topic. Competitors MAY NOT discuss or reveal the secret topic until after the event has concluded or will face penalties per the GRRs.

15. Judges will provide information to competitors as directed by the rating sheets. Competitors may ask questions of the judges while performing skills if the questions relate to patient physiology and will be included in the scenario.

Final Scoring

16. The competitor must earn a score of 70% or higher on the combined skill(s) of the event (excluding the test and ID lab equipment) in order to be recognized as an award winner at the ILC.

17. Final rank is determined by adding the round one test score plus round two skills score. In case of a tie, the highest test score will be used to determine the rank.

Skill I- Measurement of tension, stress, and strain under physiological load.

Background:

Stress is the calculation of force acting over an area and represents the measure of internal resistance exhibited by a material. Strain is a ratio of how much a material has deformed and the original dimensions of the material. The elastic modulus is the ratio of stress and strain, graphing this relationship can be useful for determining material properties. This information can be represented with the following equations.

Stress = F/A, F = Force, A = cross sectional area

Strain = dL/Lo, dL = change in length, Lo = original length

Elastic Modulus = Stress/Strain

Procedure:

1. Mark regions on either end of the material where clamps will be attached.
2. Measure the cross sectional area of the material and the length between clamp marks.
3. Set up testing apparatus (ring stand, 2 prong swivel clamp, spring clamp, foam pad, testing material).
4. Attach varying masses to the apparatus and measure the material's deformation.
5. Calculate the stress and strain of the material and plot, determine the elastic modulus from the plot.
6. Make observations on the material's properties based on the plot.

Equipment/Supplies:

Competitor Provided:

- Safety glasses
- Sharpie
- Graph Paper
- Pen/Pencil
- Calculator

Organizer Provided:

- Ring stand
- 2 pronged swivel clamp
- Spring clamp with hole
- 5x hooked masses of varying weight
- Meter stick/ruler
- Vernier calipers or micrometer
- Material for testing
- Foam pad

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Skill I- Measurement of tension, stress, and strain under physiological load	**Possible**		**Awarded**
1. Competitor accurately marks clamp points on the material with a minimum of 1 cm from the ends of material.	1	0	
2. Accurately measured and calculated the cross sectional area of the material.	2	0	
a. Accurately measured the length between clamp marks.	1	0	
3. Set up apparatus. a. Foam pad is placed at the base of the ring stand.	1	0	
b. 2 prong swivel clamp securely attached to ring stand at appropriate height.	2	0	
c. Material is attached to clamps accurately at both clamp marks.	2	0	
4. Attach varying masses and measure deformation. a. Safety glasses are worn before testing begins.	1	0	
b. 5 masses are safely added and removed, accurate measurements of deformation are taken.	5	0	
5. Calculate stresses and strains and plot data. a. The force of gravity due to each mass is calculated correctly.	1	0	
b. Stress is calculated correctly for each mass.	1	0	
c. Strain is calculated correctly for each mass.	1	0	
d. Stress and strain are plotted with strain on the x-axis.	1	0	
e. The elastic modulus of the material is found based on the slope of the plotted data.	1	0	
6. Make observations about the material properties from the plotted data.	2	0	

a. Deformation of material is properly identified as plastic or elastic.		
Total Points **70% Mastery for Skill = 15.4**	**22**	

Skill II- Performance of aseptic technique/volume transfer.

Background:

Aseptic technique involves any procedure that is conducted in a sterile environment. In this case of volume transfer of a solution every surface the solution contacts needs to be sterilized using open flame. The procedure is relatively simple, but detailed steps must be taken to ensure the bottle of solution, test tubes, and workspace is made sterile.

Procedure:

1. Prepare a sterile workspace.
2. Transfer 2.00 mL of sterile media to a test tube.
3. Clean the workspace.

Equipment/Supplies:

Competitor provided: n/a

Organizer provided:

- Sink
- Disinfectant wipes
- Bunsen burner
- Disposable glass pipettes, either 2 mL or 5 mL
- Pipette bulb
- Bottle of “media” with replaceable lid
- Test tube with cap
- Sharps container

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Skill II : Aseptic Technique and Volume Transfers	Possible		Awarded
*** Judge instructs competitor to prepare a sterile workspace** 1. Washed hands before touching any equipment a. Turned on warm water	2	0	
b. Dispensed soap and scrubbed hands for at least 20 seconds	2	0	
c. Rinsed soap, allowing water to run downward off of the fingers	1	0	
d. Dried hands with paper towel and used paper towel to turn off faucet	2	0	
2. Disinfected lab bench a. Wiped entire surface with disinfectant wipes	2	0	
b. Allowed disinfectant to evaporate	2	0	
3. Created a sterile field a. Lit Bunsen burner	2	0	
b. Adjusted flame until blue cone was visible	2	0	
*** Judge instructs competitor to transfer 2.00 mL of sterile media to a test tube** 4. Prepared glass serological pipette a. Held serological pipette in left hand	1	0	
b. Opened top of sleeve with right hand, keeping the remainder of the pipette covered	2	0	
c. Connected pipette bulb to serological pipette, holding bulb in right hand	2	0	
d. Removed sleeve and set aside for later	2	0	
e. Passed bottom third of serological pipette through Bunsen burner flame	2	0	
5. Aspirated sterile media a. Held media bottle in left hand	1	0	
b. Removed cap with right hand, holding the cap against the palm with ring or pinky finger	2	0	
c. Held the open bottle at a 45° angle and passed the rim through the Bunsen burner flame	2	0	
d. Inserted the pipette and aspirated sterile media	2	0	
e. Read aspirated volume while holding the pipette vertically	1	0	
f. Held the open bottle at a 45° angle and passed the rim through the Bunsen burner flame	2	0	
g. Replaced cap and set bottle aside	2	0	
6. Transferred sterile media a. Held test tube in left hand	1	0	
b. Removed cap with right hand, holding the cap against the palm with ring or pinky finger	2	0	
c. Held open test tube at 45° and passed the rim through the Bunsen burner flame	2	0	
d. Delivered sterile media to test tube	2	0	
e. Held open test tube at 45° and passed the rim through the Bunsen burner flame	2	0	
f. Replaced cap and set test tube aside	2	0	

g. Slid serological pipette into sleeve to remove	2	0	
h. Discarded serological pipette into biohazard sharps container	2	0	
*** Judge instructs competitor to clean the workspace** 7. Completely closed gas line to Bunsen burner	2	0	
8. Disinfected lab bench a. Wiped entire surface with disinfectant wipes	2	0	
b. Allowed disinfectant to evaporate	2	0	
9. Washed hands a. Turned on warm water	2	0	
b. Dispensed soap and scrubbed hands for at least 20 seconds	2	0	
c. Rinsed soap, allowing water to run downward off of the fingers	1	0	
d. Dried hands with paper towel and used paper towel to turn off faucet	2	0	
TOTAL POINTS **70% Mastery for skill = 44.8**	**64**		

* If all handed tasks are performed correctly with exactly opposite hands, full points shall be awarded (i.e., all left-handed tasks performed with the right hand and all right-handed tasks performed with the left hand).

Skill III- Measurement of solution viscosity.

Background:

The viscosity of a solution can be calculated by measuring the velocity of a sphere as it travels through a solution using the following equation:

$$\eta = \frac{2(\rho_s - \rho_L)R^2 g}{9v_t}$$

Where,

η = Viscosity, ρ_S = Density of solid, ρ_L = Density of liquid, v = velocity (distance/time), R = radius of sphere, g = acceleration due to gravity.

Procedure:

1. Measure and calculate density of glass sphere.
2. Measure and calculate density of solution.
3. Safely transfer beaker of PAA to new beaker for viscosity testing.
4. Measure the velocity of the glass bead as it travels through the solution.
5. Calculate the viscosity of the solution.

Equipment/Supplies:

Competitor Provided:

- Safety Glasses
- Lab Coat
- Notepad
- Pen
- Sharpie
- Calculator

Organizer Provided:

- Measuring tools (ruler, measuring tape, calipers)
- Digital Scale
- 2x 50 mL beakers (1 for tare, 1 containing soln.)

- Glass beads
- Nitrile gloves
- Timer
- Kim wipes
- Viscous solution

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Skill III- Measurement of solution viscosity.	**Possible**		**Awarded**
1. Measurement of glass sphere density. a. Accurately and appropriately measures the mass of glass bead using a digital scale.	1	0	
b. Measured diameter of glass bead using proper tool.	1	0	
c. Calculated density correctly (d = m/v).	1	0	
2. Measurement of solution density. a. Competitor followed proper glove wearing procedure while handling chemicals. The safety hazards of the material were correctly identified from the chemical safety diamond.	3	0	
b. Measured mass of solution correctly, first taring digital scale with empty beaker.	1	0	
c. Accurately measured volume of solution.	1	0	
d. Calculated density correctly (d = m/v).	1	0	
3. Safely transfer solution a. Competitor safely transferred the solution to the new beaker without spilling.	1	0	
b. Competitor held the new beaker in non-dominant hand, poured solution with dominant hand.	1	0	
4. Measure velocity of glass bead through solution. a. Distance along the test tube is measured with the correct tool (straight edge) and marked.	1	0	
b. Measurement of velocity is executed efficiently, timing is accurate.	2	0	
c. Competitor takes at least 10 time measurements to ensure good data is taken.	1	0	
5. Calculate the viscosity of the solution. a. Competitor correctly applies all variables in the viscosity equation.	2	0	
b. All units are consistent in the equation.	1	0	
TOTAL POINTS **70% Mastery for skill = 12.6**	**18**		

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