Master Activity List 2016

Biomedical Engineering

Lab-on-a-Chip: A simplified version of a lab-on-a-chip (LOC) will be built from Lego components, enabling students to analyze the structure’s individual parts. Visual aids and instructions will help guide the process. This activity represents the manufacturing side of biomedical engineering.
Location: Institute Hall (INS) Room 3120 (3rd floor)

Stratego Immunology: This lab activity mimics the classic game Stratego. Playing offense are bacteria and viruses; on defense is the innate and adaptive immune systems. Visitors will gain an understanding of how the immune system works as it protects itself from foreign invaders. This activity breaks down the immune systems complexity in a fun and interactive to show its application to vaccines and biomaterials in the biomedical field.
Location: Institute Hall (INS) Room 3120 (3rd floor)

Signals and Imaging: Visualize and analyze the signals of your own heart using an ECG machine.
Location: Institute Hall (INS) Room 3170 (3rd floor)

The Healthcare System: (R&D Engineering): Use 3D Slice Software to extract features of the brain/chest from CT and MRI scans in order to generate a 3D model, which will be shown. Also check out the 3D printed hand prosthetic devices from the e-Nable lab and explore microfluidics. (Clinical Engineering): Take a look at the pulse oximeter that you have been given. Perform research online to determine what the device does and how it works. Then discuss with others to see if you determined the same purpose of the device. (Rehabilitation Engineering): Check out the given website and discuss what you found!
Location: Institute Hall (INS) Room 3170 (3rd floor)
**Chemical Engineering**

**Rainbow in a Jar:** Layered honey, corn syrup, olive oil, water, dish soap, and rubbing alcohol in a mason jar. Added food coloring to colorless liquids to create rainbow effects. Liquids separate based on density. Liquids remain separated if undisturbed. In other jars, we may combine liquids with similar or different densities to show what happens when you shake the jar.

*Location:* Institute Hall (INS) Room 1180 *(1st floor)*

**Liquid Curtain:** With application to the coating industry, a thin, continuous waterfall shows visible waves in diamond shapes when disturbed.

*Location:* Institute Hall (INS) Room 1180 *(1st floor)*

**Steady State:** Using an apparatus from the Chemical Engineering Department, students will attempt to crack a system that is under steady state. Valves control the input and output streams in the system, so by turning the valves the students can find the right combination to achieve steady state.

*Location:* Institute Hall (INS) Room 1180 *(1st floor)*

**Cornstarch Monsters:** A mixture of cornstarch and water will be placed on a speaker. When the speaker is turned on (@ ~20 Hz), the vibrations cause the mixture to rise, forming “monsters”. There will also be 1-2 bowls containing cornstarch & water mixtures that the students will be instructed to try mixing at different speeds.

*Location:* Institute Hall (INS) Room 1160 *(1st floor)*

**Surface Tension Boats:** Manipulate the surface tension of water with as little denatured alcohol as possible to propel your self-designed “boat” across the water.

*Location:* Institute Hall (INS) Room 1160 *(1st floor)*

**Computer Engineering**

**Arduino Robots:** In this lab, students will use a fun interface to explore Arduino robots and the code that makes them run. They will drag and drop commands that replicate the chunks of code that control the robots. These bots are controlled by code written in C, but this interactive program makes coding easy through the use of drag and drop blocks. Kids can avoid worrying about things like syntax and just select the commands they want to use while exploring the basics of coding.

*Location:* Gleason Hall (GLE) Room 3460: NXP Lab *(3rd floor)*

**Blinking Pendant:** Participants will design a pixel-by-pixel image. The image will be uploaded to the Blinky Pendant and the image will be programmed to the board. When the participant waves the board through the air, the image will be displayed.

*Location:* Gleason Hall (GLE) Room 3460: NXP Lab *(3rd floor)*
**Digital Logic:** Students will learn about the functionality of various logic gates, specifically AND, OR, and XOR gates, with the use of buttons, logic gates, and LEDs. Buttons will be pressed to simulate a truth table and the gates will be determined based on results. Students will also have the option of creating a simple circuit with a NOT gate, or inverter. The circuit will consist of a button, a NOT gate, and a LED.

Location: Gleason Hall (GLE) Room 3460: NXP Lab (3rd floor)

**Inside a Computer:** Students will be introduced to the five main components of a computer: the motherboard, CPU, hard drive, RAM, and power supply. The focus is on how the parts function and work together to make a computer. The motherboard handles communication between parts, the CPU is the brain, the hard drive is the main memory, RAM is a smaller, faster memory to speed up processing, and the power supply provides power to all the components. With the help of a detailed instructional handout, they will then build a computer with these five components.

Location: Gleason Hall (GLE) Room 3452: Computer Engineering Mentoring Lab (3rd floor)

**Electrical Engineering**

**Basic Circuit Control:** An antitheft circuit on a bread board, with a toggle switch, LED, photo resistor, and IC chip. The LED shows if the photo resistor has been uncovered at all.

Location: Gleason Hall (GLE) Upper Gordon Atrium (2nd floor)

**Robotics:** NXT LEGO Mindstorm robots have different sensors attached, such as light sensors, ultrasonic sensors, which will allow people to interact with the robots and see how they react.

Location: Gleason Hall (GLE) Erdle Commons (1st floor)

**Antenna Theory:** The demo uses a transmitter and receiver, which displays the power of the signal of an antenna. By placing drywall in-between the transmitter and receiver you can see that the signal is not interrupted. Then, by placing a piece of metal mesh in-between them you can see that the communication is lost. People can also wave their hands in-between the transmitter and receiver so that they can observe the varying strength of the signal.

Location: Institute Hall (INS) Room 1080 (1st floor)

**Basic Logic Circuits:** After covering what AND, OR, and NOT gates do, students get the chance to make up their own logic circuit. They’re given 4 inputs (pushbuttons linked to LEDs), a choice of up to 4 gates, and they can see what makes the output equal 1 (aka, light up the LED at the output).

Location: Institute Hall (INS) Room 1080 (1st floor)
Microcontrollers: The MSP430 Launchpad microcontroller and capacitive touch keypad measure where on a board you touch and light a specific LED based on the location. Each area of the board had its own sensor which measures capacitance. Capacitance is the measure of a capacitor’s ability to store electric charge (think of batteries.) When the board is pressed, the capacitance changes, which signals the LED to light up.
Location: Institute Hall (INS) Room 1080 (1st floor)

Industrial Engineering

Ergonomic Activity: Ergonomics is the branch of engineering science in which biological science is used to study the relation between workers and their environments. Industrial engineers use ergonomics to make work tasks easier on their bodies, which improves the quality of the work they do. In this activity, students will have the opportunity to learn the correct, most efficient way to lift boxes while completing worksheets that show ergonomic applications in everyday life.
Location: Gleason Hall (GLE) Upper Gordon Atrium (2nd floor)

Sustainability Pyramid: In this activity, students will learn about how the decisions that Industrial Engineers make to improve the sustainability of a project can impact the world, emissions, and our carbon footprint as a whole. Using a large cardboard pyramid shape and smaller laminated triangles that represent different aspects of product design, students discuss and make decisions in order to prioritize design factors that contribute to sustainability.
Location: Gleason Hall (GLE) Upper Gordon Atrium (2nd floor)

Applying Kaizen Thinking at Home, School, and Work: This activity demonstrates different types of wastes in a tedious process that people typically don’t notice or attempt to eliminate. It will aim to help participants understand forms of waste almost everyone experiences in a typical day: time, inventory, motion, waiting, overproduction, over processing, and defects. The lab activity is extremely simple - the participant acts as a teacher who wants her students to do a STEM activity that will take up the entire class period so they must prepare the materials in advance. They have 15 students so they want to do the preparation work quickly. Using a timer, the participants will see how long it will take them to prepare the activity. After discussing how the activity can be improved by eliminating certain wastes, the participants will go through the activity again and compare both runs. This activity uses mostly recycled or recyclable products - it is important that participants can visually see how industrial engineering concepts begin to flow together.
Location: Gleason Hall (GLE) Lower Gordon Atrium (1st floor)

Solving Puzzles with Operations Research: Operations Research is used by Industrial Engineers to make decisions and solve problems. Many problems in industry can be looked at as puzzles. Operations Research can be used to solve
these puzzles as well as fun puzzles many of us do every day! In this activity students will be able to choose a puzzle and work on a solution (Sudoku, peg game, word puzzles, etc.) Students will brainstorm rules that might determine how these puzzles are solved (ex. In a Sudoku puzzle two number 9s cannot be placed in adjacent squares). Then students can learn how computers and operations research can be used to solve this same puzzle, how their rules are turned into computer commands and how this strategy could be used to solve problems for a company.

Location: Gleason Hall (GLE) Lower Gordon Atrium (1st floor)

**ISEE Toyota Production Systems Lab Assembly Line:** There will be a single line set up in the Toyota lab to create Lego cars. After building the cars, we will discuss the assembly line process and standard work. We will talk about how building the car on an assembly line is different from building it at home on the living room floor. We will then relate that concept to assembly lines in the real world and talk about how standard work can make processes more efficient.

Location: Gleason Hall (GLE) Toyota Production Systems Lab: Room 1150 (1st floor- entrance located in Lower Gordon Atrium)

**Mechanical Engineering**

**Float-a-Boat:** Design and construct a floating device out of given materials and see how much weight can be supported before the “boat” sinks. Leading teams will be placed on the Leaderboard!

Location: Gleason Hall (GLE) Upper Gordon Atrium (2nd floor)

**Heat Transfer and Material Properties:** Students will be able to explore three different stations. Each station will analyze four different pieces of metal. One station will have the four metal pieces laying in a shallow tray with water in it. The students will feel each metal piece and figure out which one feels coldest even though they are all at the same temperature. The next station will have the four metal pieces with one end in a warm water bath. Each piece of metal will have a strip of color changing film on it that changes color according to temperature. At the final station the students will be given a small magnet in a holder to test on each of the metal plates. The students will be asked to test if the magnets “stick” to any of the metals and think about why. They will then be encouraged (if they had not done so already) to rub the magnets along the plates quickly and feel for any effects and to describe anything they felt (resistance to motion due to the generation of eddy currents in the metal).

Location: Gleason Hall (GLE) Upper Gordon Atrium (2nd floor)

**Communication Challenge:** This activity will consist of two teams of students, no more than 5 on a team. Team A will be given one minute to analyze Rube Goldberg Machine 1, while Team B is given a minute to analyze Rube Goldberg Machine 2. The two Rube Goldberg machines are unique from one another, but each consist of 2 sub-sections. At each sub-section, a constraint is placed as to how it can be replicated. Team A will then relate how to build the first sub-
section of their machine to Team B, while Team B tells Team A how to build the first sub-section of their machine. Both teams have identical supplies that will enable them to reconstruct either Rube Goldberg machine. They then have two minutes to reconstruct the others Rube Goldberg machine. This process will repeat for the second sub-section of the Rube Goldberg machine. Once both machines are completed, each team can start their Rube Goldberg machine and see if it can run successfully. At the conclusion of the test runs, both teams can compare how their Rube Goldberg design compared to our example design.

Location: Gleason Hall (GLE) Xerox Lobby (2nd floor)

**Dueling with Hydraulics: Judo Bots:** Four pre-built hydraulic bots each have a semi-stable base and one lever arm which is activated by different syringes. Students will strategically choose one bot in a pair that they, as a team, believe will lead them to victory as they duel another team’s bot. The decision making process will be facilitated by challenging each team to analyze characteristics of the bot structure, such as center of gravity or length of lever arm. Each team will have a few minutes to develop an understanding of how the bot works and practice communicating and teamwork while operating the bot. Two bots at a time will duel and attempt to destabilize and knock over the opposing team’s bot, under a 3 minute maximum time constraint. Following the duel, participants are asked to brainstorm how the considerations they took into account when selecting their bot proved helpful or not, if their bot behaved as they expected, as well as any potential design changes they might suggest or consider.

Location: Gleason Hall (GLE) Xerox Auditorium (2nd floor)

**Mechanical Advantage: Pulleys:** will be set up as shown above, using a swing set as the frame. A large mass, approximately 50 pounds, will be attached to three pulleys. Surrounding the area on the ground will be a square taped off so that those working the pulley system and those watching will not get hurt in the case that the weight falls quickly to the ground. This system will show that although a mass may appear to be too heavy to lift, pulleys will help to decrease the amount of force necessary to move it. However, although the required force is decreased, there is one downfall: the amount of cable necessary to lift the mass is equal to two times the distance one wants to lift the crate for every pulley added.

Location: Gleason Hall (GLE) Erdle Commons (1st floor)

**Mechanical Advantage: Levers:** Create one from each lever class (3) showing different arrangement of load, effort, and fulcrum prior to open house, for demonstration. The load is fixed and the fulcrum will be mobile, so girls will be able to experiment with the position and realize that when you move the fulcrum away from the effort and closer to the load, you exert a higher rotational force (torque), while also needing to travel more distance. This concept will be reinforced with pulleys.

Location: Gleason Hall (GLE) Erdle Commons (1st floor)

**Mechanical Advantage: Archimedes’ Screw:** Taking the cylinder, wind the thin tubing in a spiral from the bottom to the top. Hot glue this tube to the cylinder. Attach a handle to the top of the cylinder. Fill a clear tub/bowl full of water. Place
the screw in the water and rotate. The water should begin to climb through the tube and come out the top end of the screw.
Location: Gleason Hall (GLE) Erdle Commons (1st floor)

**Mechanical Advantage: Moment of Inertia:** Hold a bike tire and sit down on an office chair. Spin the bike tire (holding onto the rod or other item that allows the tire to rotate freely). Experiment with the position of the bike tire and the chair will rotate!
Location: Gleason Hall (GLE) Erdle Commons (1st floor)

**Tricky Towers:** Break into groups of 2-4 people to use given materials to construct the tallest tower within the allotted amount of time. First, the groups are shown the materials and then are given ~1 minute to brainstorm a design. The initial materials consist of 10 strands of pasta, 5 small marshmallows, 5 normal marshmallows, two paperclips, and one strip of tape around 6 in long. They are then given 4 min to build their tower. After the construction time, the tower must be freestanding to be judged. Tallest tower creators get their name written down on the leaderboard with the height written next to it.
Location: Institute Hall (INS) Room 1160 (1st floor)

**Microelectronic**

**Photolithography:** Students will explore the concepts of photolithography, which is the patterning of relief images via light exposure. To show how light can create patterns on materials, the students will draw designs with black expo markers on transparency sheets, then place the sheet over a piece of UV light sensitive photopaper. The designs and photopaper will then be exposed to UV light (depending on weather, either done outside in sun or inside under UV lamp). After a few minutes, the areas of the paper with no designs will turn dark blue as they are exposed, and the unexposed areas will remain white/light blue. The photopaper will then be developed in water, and hung to dry, then the students can take their exposed paper with their design on it home with them.
Engineering Hall (ENG) Hallway outside Clean Room 2700 (2nd floor)

**Ion Implant:** The goal is to explore the concepts of ion implantation, which is the bombardment of a material with ions in order to change the electrical behavior of the material. Students will drop different sized marbles/ping pong balls from different heights into clear plastic containers filled with Jell-O. The effects of the “mass” of the ion (ball size) and “implant energy” height of the drop, will be shown.
Engineering Hall (ENG) Hallway outside Clean Room 2700 (2nd floor)

**Solar Cell and Other Demos:** This activity is in broken up into two parts. The first one, which is more introductory, a person will be in the cleanroom at the microscope and a table will be set out in front of them outside of the cleanroom. The person in the cleanroom will move to different areas on a sample wafer at
different magnifications so as to illustrate the scale of the devices that we fabricate, as well as show the kids the cleanroom suits that we’re required to wear and start a conversation on why a cleanroom has to be so clean (which again is related to the tiny size of the devices). For the second part, there will be a demonstration of circuits with solar cells to show that light can be turned into usable energy.

Location: Engineering Hall (ENG) Hallway outside Clean Room 2700 (2nd floor)