Engineering Lab Descriptions  
Spring Hosting 2016

Lab 1: Hydrogels and Cancer: In the Fischbach lab, we use spongy-like jello materials, called hydrogels, to study cancer in an environment that resembles the human body composition. Using these hydrogels, we create artificial blood vessels, which mimic those in our body. We apply these systems to study how blood vessels help cancer cells to grow and move to other organs. In this hands-on workshop, we will get to work with some of the hydrogels that we use in the lab and learn how these biomaterials can be explored to create in vivo-like tumor models in a laboratory setting. We will also see how these biomaterials better mimic the biological and mechanical properties of our body compared to plastics that are commonly used to study cancer cells in biomedical laboratories.

Lab 2: Imaging Brain Disease: Do you ever wonder what it looks like when your brain is working and how things are different when it is sick? On your tour of the Schaffer/Nishimura Lab in the Biomedical Engineering department, you will learn about the latest developments in optical imaging methods that enable researchers to see individual neurons in the brain and understand how they change in neurological diseases. Using mice that develop common brain diseases, such as Alzheimer's disease, we study the changes in individual cells as disease develops. Our goal is to identify the major mechanisms that cause brain dysfunction and develop strategies to block these pathways and potentially cure brain diseases. In this demo, we will show you live mice with "windows" that let you see into their brain and you will learn how our specialized microscopes take image of individual brain cells.

This biomedical lab uses mice for research, and takes place in a dark room. It is not for the faint of heart.

Lab 3: Locating Fire Stations and/or Planning Radiation Treatments for Cancer Patients: We will first briefly discuss what Operations Research is and why you should care. Then we'll work on a simplified version of a problem that is faced by every emergency service (ambulance, police, fire) in the world - locating stations. We'll use some data from the Ithaca Fire Department to demonstrate the problem. The goal is to locate fire stations in Ithaca in an attempt to minimize the average response time to calls. To do this, we construct a mathematical model, analyze the model, and interpret the results back in reality. If time permits, or if you as a group decide you prefer it to the fire station problem, we may also look at a problem in cancer treatment involving designing external-beam radiation therapy to kill a tumor while sparing healthy tissues as much as possible.

Lab 4: Video Games for Education and Entertainment: This lab will show some of the exciting things happening in the Game Design Initiative at Cornell (GDIAC). Participants will not only see how video games are developed but will get to play them as well! Participants will be able to try Crystallize, our multiplayer 3D video game for learning languages that simulates being immersed in a foreign country. Participants will also be able to play video games that were created by Cornell undergraduates in our three video game design classes, which have produced games that have been accepted to prestigious video game festivals and played by more than 350,000 people.

Lab 5: Manipulating with a Humanoid Robot: Robots are used in factories for manufacturing, and they will someday also be in our homes. Come learn about advanced robot manipulators that are human-safe and dexterous, and find out what is hard to achieve in robotic manipulation. Participants will have the opportunity to don a virtual reality headset and see the world through our robot Baxter's eyes. They will be able to control Baxter's arms and attempt to perform simple tasks with the robot like stacking blocks.

Lab 6: Semiconductor Devices Fabrication: The transistor was probably the most important invention of the 20th Century. It is an electronic device made out of semiconductor material and can be found in
almost any circuit today. In the lab demo, we will start with the definition and theory of transistors and we'll describe how we can fabricate them. A tour is followed by a presentation of the facilities in Cornell NanoScale Science and Technology Facility Center used for semiconductor devices fabrication, measurement, and inspection. Please note shoes and clothing requirements below.

**Shoes:** Socks or stockings are required. Shoes must be closed-toe shoes that fully enclose the heel and the top of the foot. Additionally, the shoes must not have a high heel (over one inch) or a deep cleat that may hold mud or other dirt. Also, your shoes must be clean and dry when you enter the facility. **Not Allowed:** Sandals, open weave shoes, or shoes that expose the top of the foot.

**Shirt:** Your shirt must be at least a short sleeve shirt that is long enough to reach your pants (no bare midriffs) and it must not have a deep neckline. **Not Allowed:** Tank tops, halter tops, and spaghetti strap tops.

**Pants:** Pants must be full-length, from waist to ankle. **Not Allowed:** Shorts or short pants, tight pants such as "skinny jeans" or yoga pants / leggings. NO skirts or dresses.

In addition: religious headwear is generally allowed if it will fit inside a clean room suit hood (but no baseball caps, etc.), and long hair should be tied back.

**Lab 7: We Love Vortices:** The role of Vortices in aircraft wakes, turbulence and flow-induced vibrations. Vortices have been observed since the time of Leonardo, but it was not till the 1900's that it was realized that they can cause structures (think of chimneys or structures offshore in the ocean) to vibrate, possibly resonate, and cause structural failure. We have discovered a strange new resonance where, whatever the flow speed, the structure can vibrate at very large amplitude. The key to whether this will happen is having a light enough structure - below a special critical mass, you can have massive vibrations! The water facilities where we have made our discoveries will be demonstrated - it is a fun thought that even though we can study aerodynamics, we actually prefer to use water facilities - like a water tunnel acting like a wind tunnel!! We also have a computer-controlled XY Towing Tank, where we can propel bodies, like wings, around in a big tank of water, and visualize the vortices in the wake, using laser-induced fluorescence. Using VISUALISATION we can see our beautiful vortices, and try to control the formation so that, for example, we can reduce the risk of aircraft wing vortices causing damage to another aircraft. Reducing such risks explains why you wait at the end of a runway before taking off! Don't view this as a waste of time - think of it as a totally essential safety measure! In essence, vortices are beautiful but sometimes quite naughty - we must learn to tame them!!

Recently we have set up a truly exciting new facility – it’s called Cyber-Physical Fluid Dynamics (or CPFD)! A body in the flowing fluid of the "water tunnel" can move around due to the physically-measured water forces, PLUS externally imposed (in cyber space - on the computer) forces defined by entering numbers onto the computer program. The body responds as though there is a real spring, or a real damper, or even horizontal gravity (!!!), but it’s all done in software. The control system makes sure the body responds at each little time step according to Newton’s Law (F = ma), but the body is controlled to move around, subject to the combination of the actual real fluid forces and the cyber forces in the computer... CPFD really works and is TOTALLY AWESOME! I can say that because I sat back in my comfy seat while my super students in the lab made this work!!

**Lab 8: Nanofabrication:** Microprocessors in computers become faster according to the Moore’s Law: transistor count per unit area doubles every 18 months. To pattern devices to nanometer-scale structures, we use optical lithography which has been the predominant patterning technique since the beginning of the semiconductor age. Optical lithography is capable of producing sub-50 nm patterns with the use of ultraviolet light (currently 193 nm immersion). In this lab, you will get a chance to pattern (and keep!) a silicon wafer substrate with small features using the optical lithography technique. This lab will be performed in a cleanroom, which means you will get to wear bunny (cleanroom) suits!

**LONG PANTS REQUIRED. NO SHORTS, SKIRTS, SLEEVELESS SHIRTS, OR OPEN TOE SHOES ALLOWED**
Lab 9: ChemE Car Team: Each year, the Cornell ChemE Car team builds a shoe-box sized car that both starts and stops via chemical reactions and must travel a distance of 50-100 feet while carrying a water load of 0-500 mL. Precision is the key to success. The team recently took first place at the 2015 AIChE National Competition and will be traveling to UMass Amherst later this Spring to compete for the 2016 Northeast Regional Competition. Students will get to learn more about how each car is constructed, and the chemistry behind the starting and stopping mechanisms of each. Students will also have the opportunity to see how the safety, ethical, and practical constraints the team operates under relate to engineering in the real world.

CLOSED TOED SHOES AND LONG PANTS ARE REQUIRED

Lab 10: AguaClara: More than 1 billion people don’t have access to safe drinking water. AguaClara is a team of engineering students and faculty who are developing low cost and sustainable technologies to take muddy surface water and turn it into safe drinking water and then implement these technologies in small communities in Honduras and India. You will be able to see how this group of engineering students prepares to produce clean water using innovative and replicable technology for a small-scale water treatment plant.