MAKER: Nanotechnology & Microfluidics - Lab-on-a-chip

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Our First Year Engineering program has a variety of labs and exercises that run weekly throughout the semester to expose freshman engineering students to multiple engineering disciplines. One of the courses which is aimed at students who are interested in disciplines such as: Chemical Engineering, Biological Engineering and Material Science Engineering involves Nanotechnology and Microfluidics, and introduces them to these topics by utilizing a lab-on-a-chip.

There are two versions of this program, but they have many similarities. Both of the courses utilize a 2" diameter chip of 1/8" acrylic that has features machined into it that were custom designed by student teams. Both introduce the students to common lab and medical supplies such as: rubber (nitrile) gloves, disposable syringes with plastic precision tips, Kimwipes, petri dishes, PDMS, ultrasonic cleaning machines, etc.

In one version of the course the students build and calibrate an electrical circuit which is used to measure the concentration of a solution of fluorescein. This is accomplished through repeated testing using a 1000ppm solution of fluorescein to calibrate the accuracy of the testing apparatus, known as a DAD. The students are given unknown concentrations of fluorescein and use their calibrated electronic circuit to try to determine the concentration. A team of 4 students gets to design the channel geometry for their lab-on-a-chip. They study the geometry features and refine their design so that the can isolate the fluorescein solution and get an accurate reading using their DAD and testing circuit.

The alternate nano course is a little more advanced. It allows the students to use a lab-on-a-chip to study the forces and geometry required to flush a solution of yeast cells out of micro channels. The students grow the yeast solutions in the micro channels, and then later use varying pressures and flow rates of purified water to study how pressure and volume affect the flushing resistance of the yeast. The latter part of the course is a bit open ended, and the students are allowed to experiment with altering the ph and other factors of the solution to see how it affect the results.

The student teams design their chip channel geometry using SolidWorks CAD software. This geometry is then machined in-house using benchtop cnc vertical mills fitted with custom machining fixtures. This allows for a quick turn-around of chip generation, and exposes the students to the entire manufacturing process.

Throughout both courses, the students are exposed to: problem solving, electronic circuit design and testing, CAD, nanoscale hydraulic features, precision fluids measurement, common chemistry and biology lab practices, cnc fabrication, teamwork, collaboration and data collection and documentation.

*The next submission of this project will be in a format that is more appropriate for a poster presentation, and include photos and diagrams relevant to the subject matter.