CLUSTER 5: FROM LASERS TO LCDS: LIGHT AT WORK

After an eventful Opening Day and introduction to COSMOS, our first day as a group in Cluster 5 began with an interesting Laboratory Safety Training session where we learned about proper eye protection when working with lasers. With many types of lasers that operate at different wavelengths, it is very important to use protective glasses that correspond to the proper wavelengths to ensure safety. Immediately after the safety training, we were able to get started with a lecture from Dr. Charles Tu on some of the amazing ways light contributes to technological advancement in communications, energy production, health and biomedical applications, and nearly every aspect of science and life in general. After lunch, we went to the Photonics Lab in the Jacobs Engineering Building to learn about light refraction, prisms, and Snell’s Law from Dr. Peter Ilinykh. Students then had the chance to conduct a lab with a Helium-Neon (HeNe) laser and a prism to verify Snell’s Law experimentally and find the critical angle of the prism.

On Tuesday, our day began with an amazingly interesting guest lecture from Dr. Tina Ng on flexible electronics, OLEDs, biomedical applications like mechanoreceptors in prosthetic limbs that can transmit feeling to neurons, and many other advanced applications of electrical engineering technology. After a look at our Science Communications curriculum and lunch, we tackled another lab with Dr. Ilinykh, this time involving prism refraction and diffraction grating spectrometry. Students took data to calculate the resolving power of the prism and the line spacing of the diffraction grating.

On Wednesday, the day started with an in-depth lecture from Dr. Tu on semi-conductor physics, n- and p-type doping, quantum numbers and energy levels, LEDs, and refraction and diffraction of light. Our laboratory work on this day involved a fun mini-project on mobile spectrometers. Each student had the opportunity to build their own spectrometer out of cardstock and a piece of a compact disc (CD) to use as the diffraction grating. Students took data using their mobile phone and uploaded the spectra to a great website called Spectral Workbench in order to analyze the data in detail. Students even got to take their spectrometer with them to keep.

On Thursday, students got some helpful training on how to utilize the vast library resources online at UCSD before continuing work on their Ethics Essays. Students chose their topics and started researching relevant sources. In the afternoon lab session, students worked with LEDs and analyzed different wavelengths of light through various methods. It is becoming very evident that nearly every aspect of physics and engineering that relate to optics will be addressed throughout our lecture and lab sessions, and students will continue learning a lot!

We will be sure to keep you updated on Friday’s happenings in the next newsletter. Please know that your students are learning, growing, and enjoying the beautiful (and occasionally sweltering) San Diego weather!
We are already finishing up our second week of COSMOS! It sure is going fast, but that’s what happens when you’re having fun! Students in Cluster 5 are really settling in and getting comfortable with the morning lectures and afternoon labs, while still finding time to work on their Ethics Essays and have fun with their fellow COSMO-nauts. ;)

Last Friday, students had the chance to create their own functioning solar cells that utilized blackberry juice to sensitize the device and absorb light. They got down and dirty to smash the blackberries and strain the juice, coat the conductive glass cell with a titanium dioxide paste, bake the cell components, and construct and test the device to see which group could get the most current to flow from their cell.

On Monday of Week 2, the morning lecture started with a discussion with Dr. Charles Tu about the various ways semiconductors and pn junctions can be used to create LEDs, laser diodes, and photodiode detectors. Next, students learned about geometrical optics (lenses, diffractions, and refraction) before getting the chance to see a wonderful demonstration from Dr. Janet Pan on spherical and chromatic aberrations with lights and lasers passing through a clear jar of water that acts as a cylindrical lens. During the afternoon lab session, students continued their exploration of semiconductor lasers and LEDs.

On Tuesday morning at the Discovery Lecture, students had the privilege to listen to a talk from Dr. Henrik Christensen on the latest developments in robotics, human-robot interaction, and how robots will be used to improve the quality of life of everyone in society. Next, students worked together to peer-edit their Ethics Essays for submission later this week. Some of the student essay topics have been extremely interesting and wide-ranging in terms of important ethical issues related to light and society, including laser surgery, light pollution, and LIDAR speed detection, among many others.

On Wednesday, the morning lecture began with a discussion with Dr. Tu and Dr. Pan of how lasers work and their fundamental role in creating the computer and smartphone technology we all use today. During the afternoon lab, students had the chance to learn about the polarization of light and how polarizers can be used in everyday applications such as sunglasses and high-tech scientific experiments with lasers. After our regular day finished, most of Cluster 5 had the chance to participate in the “Treats with Tu” session where we got to enjoy snacks and a Q&A with Dr. Tu on various topics of interest to the students.

On Thursday, the morning began with the first Cluster Exploration Session where some of the cluster professors gave the whole COSMOS program a quick look at what students in their cluster have been working on during the first two weeks of the program. Next, students had the chance to learn a bit about solar observation and solar spectroscopy with the cluster Teacher Fellow, Scott Patterson. Students then had the chance to go outside and safely observe the sun with a solar telescope and look for solar flares and sunspots. Next, we had a great guest lecture from Eric Takeuchi, the VP of Business Development at Daylight Solutions, about applications of the Quantum Cascade Laser (QCL) technology. Everyone is excited for our field trip to Daylight Solutions on Monday! During the afternoon lab session, students learned about and conducted experiments on light interference and interferometry using various laser setups.

Another busy week full of interesting, exciting, and fun science! We will keep you all updated on Friday’s happenings in the next Newsletter.
COSMOS 2018 is already 75% complete (!) and students are truly getting involved in some deep and interesting science. On Friday last week, students had the chance to learn about quantum cascade lasers (QCLs), quantum dots, LCDs, polarization of light, and holography from Dr. Tu at the morning lecture. In the afternoon, students created their own holograms using the principles of interference and the physics they learned in the morning. Many students also had the opportunity to go home or leave UCSD with their family for the Family Weekend – hopefully everyone enjoyed that time together!

On Monday this week, the morning began with some further in-depth discussion about holography and LCDs, as well as the photoelectric effect and the process of photolithography. Dr. Tu then took us on a tour of UCSD’s Nano3 Laboratory Facility, so students could see inside the various clean rooms (through the windows) where photolithography and other semiconductor processing techniques are implemented. The afternoon session consisted of our much-anticipated field trip to Daylight Solutions. The wonderful staff organized four rotating mini-tours of their facility so students could see their QCL infrared microscope (used to advance cutting-edge cancer-detection), CAD software techniques, fiber-optic cable development, and a great discussion with one of the company’s founders about optics, astronomy, and spectroscopy. It was a truly great trip!

On Tuesday, our Discovery Lecture consisted of an engaging talk from Dr. Terrence Sejnowski on Deep Learning, neural networks, and artificial intelligence. Dr. Sejnowski made interesting connections between physics, biology, and computer science that kept students very intrigued. Next, at our Science Communication session, students learned more about ultraviolet optics and how different the world looks in the UV. In the afternoon lab session, students formed their groups for their final cluster projects and started preliminary work and planning.

Wednesday began with another great lecture from Dr. Tu on CCDs and CMOS detectors, followed by a great lab demo with Dr. Janet Pan on optical scattering and rainbows. In the afternoon, students continued their initial stage of work on their projects and developed plans for completing their work by the middle of Week 4 in order to be prepared for their presentations at the end of the COSMOS program. We won’t give anything away just yet, but student groups have come up with some very innovative and interesting ideas for investigating scientific phenomena in the world of optics and photonics – it is sure to be fun!

On Thursday, the morning began with the second Cluster Exploration session where students had the chance to see what the rest of the clusters have been working on over the past three weeks. This was followed by a Science Communications session where students examined a peer-reviewed journal article in order to model their own project presentation for clarity, succinctness, and ease of understanding for the audience. In the afternoon, groups continued to make progress on their projects in the lab, as we quickly get closer and closer to the end of the program!

Friday’s happenings will be detailed in the final newsletter, and we look forward to see all the families at the Research Expo and Awards Ceremony!
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After an eventful, exciting, and fruitful month at COSMOS 2018, students are working hard right this moment to finish up their group projects and prepare for the Research Expo on Saturday. It has been a great learning experience, both academically, and in terms of overall personal growth, and the connections and friendships formed here at UCSD will undoubtedly last well beyond the conclusion of the program.

Last Friday, students joined Dr. Tu for a lecture about further applications of solar cell technology and research applications, followed by the opportunity to continue working on their group project in the afternoon lab session. After an eventful weekend including a trip to Balboa Park, the COSMOS Carnival, and the evening Dance, everyone was ready to get back to work for the final week of the program.

Monday began with a very interesting lecture from Dr. Tu on optical coupling, micro-ring resonators, and photonic crystals, followed by a tour of Professor Mookherjea’s Micro/Nano Photonics Lab. Students then continued to make progress on their projects in the afternoon, with the goal of completing data collection by Tuesday or Wednesday so they can also have time to complete their presentation and research poster.

On Tuesday, the morning began with our final Discovery Lecture from Dr. David Price on the extremely interesting topic of the Human Virome and how important and intricate the microscopic organisms living in and on our bodies are to our health and survival. Next, students spent the rest of the day pushing forward with their projects and nearing the end of their work. Students continued the last stages of data collection, analysis, and organization of ideas for their presentations. It will be a treat to see all of their hard work at the Research Expo on Saturday!

On Wednesday, students were treated to their final lecture from Dr. Tu, where he summarized the content from Cluster 5 and answered dozens of questions on the material that students submitted the day before. It was a great close to the college-style lecture experience that students will become more and more familiar with as they continue their academic careers. Next, students had a wonderful tour of Professor Lo’s lab specializing in optoelectric devices and photonic integrated circuits. Wednesday afternoon consisted of the students’ final opportunity to work on their group project and finalize data analysis and their presentation and poster.

On Thursday, students were able to practice their presentations for various audiences and get feedback on how to improve their slides, clarity of ideas, and overall effectiveness of communicating science to an audience.

On Friday, Cluster 5 and Cluster 4 will join up for a more formal research presentation rehearsal in the morning, where each group will have the chance to present their final work to an audience of peers. In the afternoon, we will all have a chance to attend a mini-field trip at the Qualcomm Institute on campus at UCSD as a dose to our COSMOS activities. After that, we will be looking forward to the Research Expo and Awards Ceremony on Saturday before finishing up the amazing COSMOS experience and heading back home!