# THE LAB'S in the MAIL

Teamwork in the Electrical & Computer Engineering Department ensures that students in required classes have what they need to do lab work at home

UC Santa Barbara engineering students who are taking ECE 10A or 10C in this fall quarter probably do not fully grasp what it took to ensure that they can do hands-on lab work for the courses, which are being taught remotely.

Second-year electrical engineering majors at UCSB must normally take those two courses, plus a third, ECE10B; together they make up the Foundations of Analog and Digital Circuits & Systems requirement. Students learn the essentials of analog and digital circuits in 10A, are introduced to MOSFETs (metal–oxide–semiconductor field-effect transistors) in 10B, and learn the basics of transient analysis (a circuit's response over time) in 10C.

Each course includes a lab to provide hands-on experience in applying core knowledge. Last spring quarter, when the COVID pandemic closed campus labs — undergraduate labs will remain closed at least through fall quarter — the ECE 10 labs were run online, with simulations taking the place of hands-on work. When summer arrived, department faculty, including department vice-chair **Clint Schow** and assistant professor **Galan Moody,** came up with a plan for fall quarter that would afford students the critically important hands-on experience. "We concluded that online simulations weren't the way to go," says Moody.

"The students really need to work with the hardware to build an intuitive and conceptual understanding of the content in the lectures," Schow adds.

But that hardware is prohibitively expensive. The solution was to put together and mail to each student, wherever they might be, a package containing the parts needed to do the lab assignments at home. The main piece is an Arduino board, which costs only about $50, as opposed to an alternative that costs $500. Arduino is an open-source electronics platform based on easy-to-use hardware and software. The programmable board has a micro-controller that can read inputs, such as a light on a sensor or a finger on a button, and turn them into an output to perform some action, such as activating a motor or turning on an LED.

The task of ensuring that these mailed lab packages would work fell to four doctoral students who are TAs in the various ECE10 courses: **Nikita Buzov, I. T. Fufuengsin, Shabnam Larimian,** and **Kamyar Parto.** Their work involved "tweaking" the Arduino board to give it the required functionality, because, as Parto said, the cheaper instrument came with measurement limitations. "This is not necessarily a bad thing," he told students in a written message. "The definition of being an engineer is having the ability to adapt to come up with a smarter way."

Their "smarter way" involved accessing and tweaking a lower level of the Arduino's software, so that it could function as a generator. "Normal users are not supposed to do that with an Arduino board, but we did it, and it worked fine, says Parto. "We also modified some codes so that it can function as an oscilloscope. That's the key thing we did, and now we can do a lot of processes with a fifty-dollar device that would normally require a thousand-dollar device."

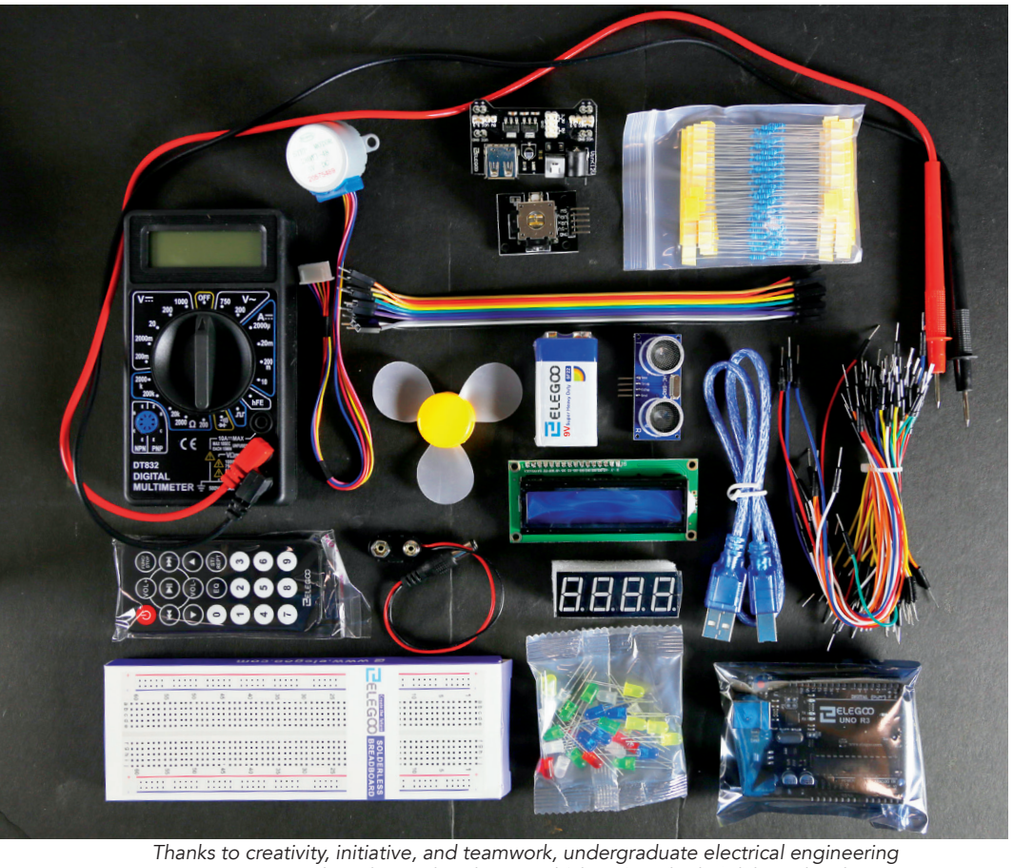
They tested the Arduino by using it to do all the labs in the course and then adjusting them as needed given the board's somewhat different abilities.

"I feel good that we now we have the actual physical lab so that the students can really touch the stuff and work with the physical parts. It will help them for the future," says Larimian. "I think, too, that at the end of this year, the students will be able to problem-solve and debug the circuits even better than the students before who were present in the class on campus. Doing the labs independently, they'll learn the material much better."

ECE shop director **Paul Grit** and his colleague **Chris Wimmel** assembled and mailed the kits, which included the Arduino board, a "breadboard" (a kind of blank canvas for building electronic circuits), a digital multimeter, LEDs, operational amplifiers, capacitors, inductors, and resistors.

"The graduate students are heroes for this," Moody says. "It would not have been possible without them."

Schow said that he is very pleased with the result, adding, "It's a great example of everyone not doing the easy thing but realizing what the right thing was to do and then pulling together to get it done as best we can under tight circumstances with limited resources."




*Thanks to creativity, initiative, and teamwork, undergraduate electrical engineering students have what they need (above) to do their lab work at home.*