

## EM course is gateway to many career paths

By Erin Lukehart



N. Narayana Rao, the Edward C. Jordan Professor of ECE, presents the new edition of his "Elements of Engineering Electromagnetics" to his former student Tony Zuccarino (BSEE '83), entrepreneur in residence at Benchmark Capital. The book has been used as the ECE 350 textbook for many years—a course Zuccarino took in the early 1980s.

Developed more than 50 years ago with the advent of electrical communication and high frequency electronics, ECE 350 (recently changed to 450)—Lines, Fields, and Waves—has been a longstanding staple of the department and continues to challenge and inspire the students who take it.

Associate Department Head N. Narayana Rao taught the course regularly from his arrival to the department in 1965 through the 1980s, and infrequently later on. "This course was developed as a fundamental subject for electrical engineers," said Rao, the Edward C. Jordan Professor of ECE. "It is still fundamental because all electrical engineering has become very broad now. All courses having to do with wave phenomena branch off from this course."

ern the interaction of electromagnetic waves with matter," said current course director Professor Andreas Cangellaris, who has been teaching the class off and on for the past seven years.

The aim of ECE 350 is to present students with the application of electromagnetic theory and electromagnetic fields. For their homework, students use computer-based visualization aids designed by Professor Umberto Ravaioli, who also teaches ECE 350.

"We use the applets so students can probe a bit further into some of the application- and design-driven quantitative manipulation of electromagnetic field equations and concepts that we don't have time to work through in detail in class; this allows students to see how these concepts apply in the real world," said

Considering the course's emphasis on mathematics and theoretical concepts, you'd be hard-pressed to find a student who would describe ECE 350 as easy. "The course requires very good skills in mathematics, especially calculus and vector calculus, and in addition requires the willingness of the student to intuitively think about the physical phenomena that govern

Cangellaris.

Although ECE 350 is not required, Cangellaris noted it is in many ways a "gateway" course, essential to any students wishing to pursue a career in fields such as communications, microwave engineering, or solid-state electronics.

Cangellaris suggested the course could also be relevant to students pursuing digital circuit design. "Many of the concepts described in this course are extremely useful to understanding how the millions of transistors in high speed CPUs—the chips that Intel makes for our computers—transmit information between each other," he said. "They also explain how sometimes undesirable noise generated by these transistors causes all sorts of interference problems that may actually prevent the processor from working at its best."

Like many other alumni, Tony Zuccarino (BSEE '83), Entrepreneur in Residence at Benchmark Capital, said the concepts he learned from ECE 350 proved valuable after graduation. "[This course] definitely was of high practical value in my very first engineering job out of school," explained Zuccarino. "Most of my time has been spent in communications and networking, and so understanding of lines, fields, and waves proved absolutely fundamental to understanding the technical landscape."

John Cioffi (BSEE '78), Hitachi America Professor of Engineering at Stanford University, has returned to principles learned from ECE 350 in his work with DSL technology, a field that he helped to pioneer and has been working in for 25 years.

EM course, continued on page 22

### Connexions,

continued from page 16

the material.” There has also been an interest in translating the material into other languages, such as Chinese, Japanese, Thai, and Spanish.

Baraniuk’s approach to Connexions is interdisciplinary, and he hopes in turn to cultivate a sense of interconnectedness between subject areas through the site. This type of approach is not new to Baraniuk, whose graduate research fused engineering with applied mathematics. Under Professor Jones, he worked in time-frequency analysis.

“In time-frequency analysis, the idea is try to build mathematical tools that allow you to look at signals in the same way that a musical score lets you look at music,” he explains. “We built mathematical representations for other kinds of signals that have that same kind of visual character. And they get used all the time in everything from speech processing and speech recognition to cell phones, sonar, and radar.”

Through Connexions, Baraniuk ultimately dreams of creating a global community of authors—a free intellectual exchange of information between contributors and learners. Baraniuk happily notes that 96 percent of the site’s traffic comes from outside of Rice University. “Currently we get over 300,000 hits on our server per day,” he says. “We’d like to be up to about 3 million hits next year.”

Connexions currently hosts more than 2,500 modules and 50 courses, and it only continues to grow. “It wasn’t just pie-in-the-sky educational technology for its own sake, and I think that’s one of the reasons why it’s been a success,” says Baraniuk. “It actually tries to solve real problems.”

### EM course,

continued from page 18

“[DSL] uses twisted pair telephone lines to send high-speed digital data to the normal home at the end of the telephone line. You need to be able to model what the telephone line looks like, and that type of modeling is what was taught in Professor Rao’s class,” Cioffi said.

Not only is the course itself woven into ECE tradition, so is the course’s textbook. “Elements of Engineering Electromagnetics,” authored by Rao and first published in 1977, has been used as the ECE 350 textbook for many years. The book is also utilized for ECE 229, Introduction to Electromagnetic Fields, which is a required course and a prerequisite for ECE 350. Rao’s textbook recently reached its sixth edition, and has the distinction of being the first book to kick off the new Illinois ECE Series for Prentice-Hall.

Cioffi took ECE 350 when Rao had just finished the first edition of his textbook. “I remember him passing it out [as] hand-typed notes in the class,” Cioffi recalled. “It was a difficult subject, but pretty easy to take given the level of care that he put into it.”

ECE 350 is a course known for its great challenges, but it also reaps many rewards. “While it is oftentimes challenging for the students to combine the rigorous math with the intuitive physical thinking about waves and fields,” said Cangellaris, “I think in the end they come out much more confident about their electrical engineering knowledge and skills.”

### Trick retires,

continued from page 19

tionwide. ECE Professor Ricardo Uribe developed the lab portion of the course.

“I didn’t want 110 to be an easy seminar course where students just attend and maybe read some stuff and write a report,” said Trick. “I wanted to really teach students about electrical devices, circuits, and the systems in which they are used.”

Students learn concepts in circuits, electromagnetics, electronics, control, and digital systems during lectures. In the lab, they design and build the circuitry necessary to transform an electric chassis into an autonomous vehicle that can follow a path on a track.

Another accomplishment was the redesign/renovation of ECE’s 20 instructional labs in the early 1990s. Working with ECE Associate Head Narayana Rao, Trick invited the faculty to submit proposals showing how they’d modernize their teaching labs. With industry booming, Trick presented the department’s wish list to the university liaisons at various companies. The result: the department received more than \$10 million in gift donations and equipment, enabling the department to upgrade all its instructional labs.

After stepping down as head in 1995, Trick became director of two college-wide endeavors to use new technology to enhance engineering education: the Sloan Center for Asynchronous Learning Environments and the Lois and Harlan Anderson Laboratory for Global Education in Engineering.

Since retiring in May 2004, Trick has been working on a manuscript for a freshman ECE textbook. He and his wife Dorothe have also visited grandchildren in California, Vermont, Florida, and Illinois. Their most exciting trip, though, was to Ireland, visiting distant relatives including the brother of Ireland’s former president, Mary Robinson.