UCLA
Electrical Engineering Department

Annual Report 2005-2006

Interior of UCLA Powell Library

From the
Department Chairman

The 2005-2006 academic year was exciting and forward-looking for our department, with several initiatives in place affecting our infrastructure, faculty, students, and scholarly environment.

The department recruited tirelessly over the course of the academic year and as a result interviewed thirty-two faculty candidates, and hired four exceptional junior faculty members. One common thread is the cross-disciplinary nature of their work. The potential exists for creating fruitful interactions ubiquitously.

The department continued its vigorous research program with a healthy funding level per faculty, which is among the highest in the nation. Our faculty is actively engaged in several research centers and institutes of international prominence. Our faculty and students continued to garner prestigious honors in recognition of their achievements. We also take pride in the associations of six of our faculty that are members of either the National Academy of Engineering (NAE) or the National Academy of Sciences (NAS), or both.

The department continued to nurture its strong undergraduate and graduate education programs. We evaluated both programs recently in order to ensure that we are preparing our students appropriately for the ever-changing landscape of electrical engineering. Students need to be prepared to navigate across multi-disciplinary boundaries with strong foundations.

It is also necessary that they are offered a flexible curricular structure that encourages them to reach across disciplines to broaden their training.

In this spirit, the department made recent changes to the program requirements for its B.S. degree. Students are now required to select their elective courses from within pathways with a common theme (e.g., the circuits pathway or the signals and systems pathway). In this way, students will get more in-depth training in an area of interest. Students are also required to take a coherent set of three upper-division courses from outside electrical engineering. In addition, we streamlined the sequence of mathematics courses in order to strengthen the linear algebra and differential equations components. A separate Statistics for Engineers course is a new requirement.

The graduate program is also undergoing changes in order to enhance its flexibility and to promote and encourage multi-disciplinary research programs. We restructured the department into three major areas of research: Circuits and Embedded Systems, Physical and Wave Electronics, and Signals and Systems. Students and advisers will have greater flexibility in the selection of courses for graduate studies.

We are proud of the contributions of all the faculty, staff, and students to our vibrant department. With their support, we are looking forward with optimism to another exciting year and moving toward our goals with conviction.

Ali H. Sayed
Department Chairman

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Overview

Faculty and Staff

Ladder Faculty	49
Joint Faculty	8
Emeritus Faculty	7
Adjunct Faculty	10
Lecturers	33
Department Staff	46

Recognition

Society Fellows	31
NAE Members	6
NAS Members	2
National Medal of Science	1

Publications

Books	6
Book Chapters	6
Journal Articles	180
Conference Papers	201
Patents	13

Researchers at the Nanoelectronics Research Center

Research Facilities

Laboratories and Research Groups: 29

Space: 102,669 square feet

Department Contributes to 8 Research Centers:

- California NanoSystems Institute (CNSI)
- Center for Embedded Networked Sensing (CENS)
- Center for High Frequency Electronics (CHFE)
- Flight Systems Research Center
- Functional Engineered Nano Architectonics Focus Center (FENA)
- Institute for Cell Mimetic Space Exploration (CMISE)
- Nanoelectronics Research Center (NRC)
- Western Institute of Nanotechnology (WIN)
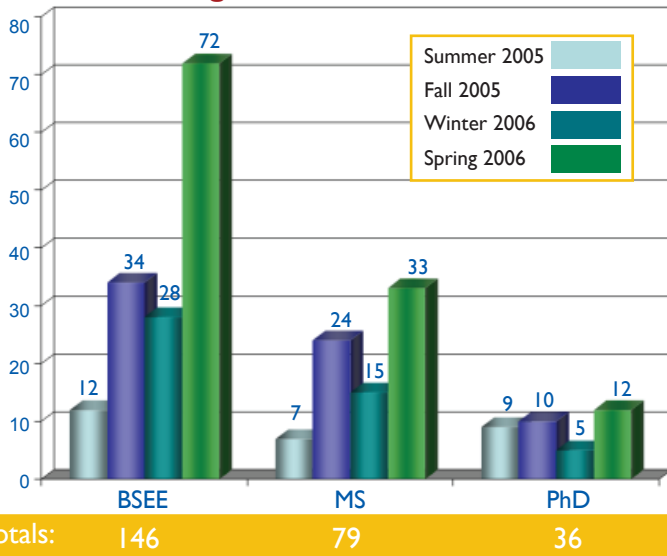
Research Funding 2005-2006 ($20 M)

Federal $11.5M (57%)

Industry $7.2M (36%)

State $1M (5%)

University & Endowments $.3M (2%)
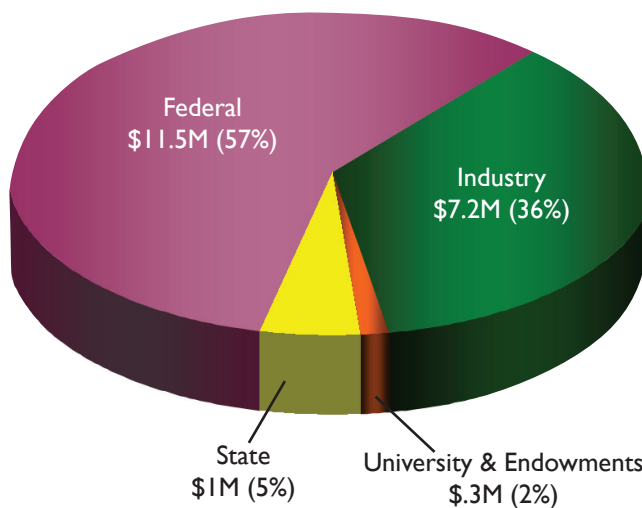
Undergraduate Students

Students Enrolled	497
Applicants	906
Admitted	346
New Students Enrolled	120
Acceptance Rate	38.2%
Average Freshman GPA	3.88/4.0

Graduate Students

Students Enrolled	372
Applicants	1159
Admitted	331
New Students Enrolled	123
Acceptance Rate	28.6%
Average GPA	3.82/4.0

EE Degrees Conferred 2005-2006

Legend:
- Summer 2005
- Fall 2005
- Winter 2006
- Spring 2006

BSEE: Summer 12, Fall 34, Winter 28, Spring 72
MS: Summer 7, Fall 24, Winter 15, Spring 33
PhD: Summer 9, Fall 10, Winter 5, Spring 12

Totals:	BSEE 146	MS 79	PhD 36

Graduate Applicants for Fall 2005

Countries with over 5% of 1159 total applicants

- United States: 390 — 34%
- People's Republic of China: 249 — 21 %
- Republic of China: 127 — 11%
- India: 119 — 10%
- South Korea: 112 — 10%
- Iran: 73 — 6%
- Other: 92 — 8%
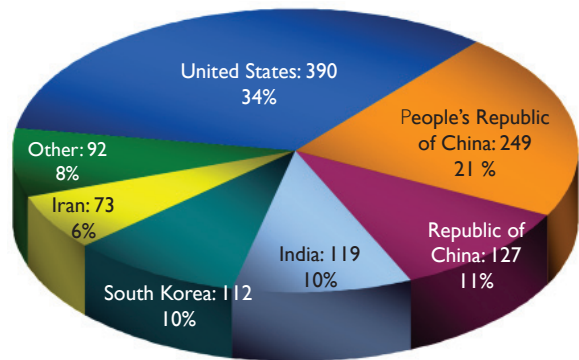
Fellowships Received by Electrical Engineering Students

Combination Fellowships	$ 54,6704
Full Fellowships	$ 92,212
CNID/CNSI Fellowships	$ 299,686
Non-Resident Tuition Support	$ 277,971
John De Groff Haller Memorial Fellowships	$ 239,405
Dean's Graduate Student Researcher Support	$ 215,000
Henry Samueli Fellowships	$ 85,923
Partial Fellowships	$ 67,193
Dissertation Year Fellowships	$ 52,753
Raytheon Fellowships	$ 52,219
Rockwell Fellowships	$ 45,122
Fellowships for Students with 4.0 GPA	$ 17,117
Chancellor's Prize	$ 10,000
Conference Travel Funds	$ 1,200
Total	**$ 2,002,505**

The Optoelectronics Circuits and Systems Laboratory

Silicon Laser Technology

Professor Bahram Jalali, Director

Bahram Jalali, whose research team and discoveries have been featured in publications such as Scientific American, Wall Street Journal, the New York Times, Nature, Science, and Scientific American, has developed a novel approach to silicon devices that combines light amplification with a photovoltaic effect.

In a paper presented at the 2006 International Optical Amplifiers and Applications Conference in Vancouver, Canada, Prof. Jalali's research group reported that not only can optical amplification in silicon be achieved with zero power consumption, but power can now be generated in the process. The team's research shows that silicon Raman amplifiers possess nonlinear photovoltaic properties, a phenomenon related to power generation in solar cells.

Prior to their work, the Raman effect had not been considered for creating silicon optical devices, since several kilometers of fiber were required to make a useful device, whereas the typical silicon chip is millimeters in size. Through their research, Jalali's group was able to significantly reduce the fiber requirements, realizing the possibility of a silicon laser. "Silicon is a crystal with a well-ordered atomic arrangement, compared to glass fiber for example, which is amorphous with a random atomic arrangement," he explains. "This results in a very strong Raman effect in silicon that can be exploited to create a laser on a chip."

Jalali's team determined that the Raman effect - or the changes in wavelength for some light photons caused when passing through transparent material – is 10,000 times stronger in

pure silicon than in glass, and can be used to amplify data considerably. The first silicon laser, demonstrated for the first time by Jalali and research engineer Ozdal Boyraz, exhibited nearly ideal characteristics and produced pulsed radiation with a very high peak power of one watt.

"We were excited to be the first to demonstrate that a laser can indeed be made on a silicon chip," said Jalali, who is also a member of the California Nano Systems Institute. "Our approach uses the natural atomic vibrations of silicon to create or amplify light, which is significant because no special impurity or complicated device structure is needed."

Professor Jalali, who worked with researcher Sasan Fathpour and graduate student Kevin Tsia in making the recent discovery, says that after dominating the electronics industry for decades, silicon is now on the verge of becoming the material of choice for the photonics industry, the traditional stronghold of today's semiconductors.

Silicon photonics technology has the potential to use the power of optical networking inside computers and to create a new generation of miniaturized and low-cost photonic components, among other applications. "This discovery is a step forward and makes it much more likely that photonics and electronics will converge. If they do, many applications that silicon photonics has promised will come to fruition," Jalali said.

Jalali's research at UCLA Electrical Engineering was funded by the U.S. Department of Defense through the Defense Advanced Research Project Agency (DARPA) and co-sponsored by the Northrop Grumman Corporation.
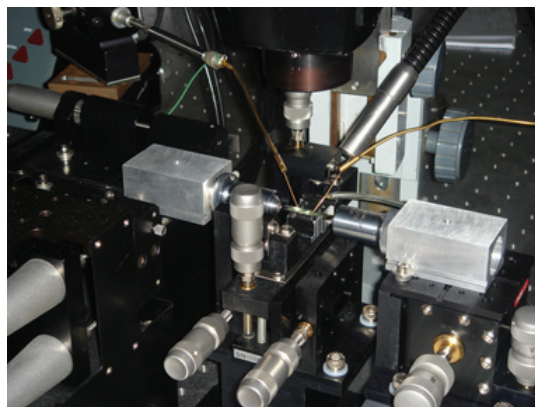
Silicon laser on which energy harvesting was demonstrated for the first time

The Networked Infomechanical Systems (NIMS) Project

Investigating Spatial Distribution of Contaminants and Flow in River and Stream Systems

*Professor William J. Kaiser, Principal Investigator*

Networked Infomechanical Systems (NIMS) is a new robotic sensor technology that combines networking, embedded computing, and electromechanical systems. NIMS is a breakthrough in sensing technology, providing autonomous and precise control of sensors in complex environments. NIMS has been developed for many applications, including exploration of forest ecosystems with sensor nodes that sample atmosphere, measure solar radiation, and image plant systems.

Recently, a new NIMS system was developed to directly provide the first "images" of the spatial distribution of contaminants and flow in river and stream systems. In collaboration between HSSEAS and UC Merced, this important NIMS RD investigation was completed at the San Joaquin River in the California Central Valley. Here, the NIMS RD system spanned 200 feet, crossing the river at a point 1km downstream from the confluence where the Merced River joins the San Joaquin. The sensors included many chemical and physical measurement devices, including sensors that indicate concentration of nitrate, ammonium, and salt contaminants along with acidity, temperature and flow measurements. The NIMS RD system uses its cable actuation systems to both raise and lower the sensor package to depth in the river and scan across the river as well. Together, these measurements form a map or image. The distribution of water quality parameters measured by NIMS RD revealed a dramatic difference across the river mixing zone.

NIMS can now be deployed in many stream, lake, and river applications where the actual flow rate of individual contaminants can be determined. This is expected to be critical in determining the origin of frequently occurring salt contamination and the interaction of contamination with neighboring land systems, a current important concern in water quality management in California and the Western U.S.
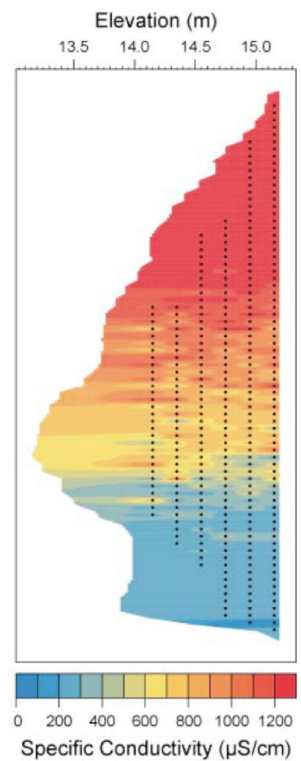
A map of river conductivity, indicating salt contamination, is shown in the panel above.

The NIMS robotic sensor system deployed in a 200 foot span across the San Joaquin river near the confluence of the San Joaquin and Merced Rivers (upper left). The NIMS sensor node (indicated by the circle) is seen at the middle of the river as it scans from one river bank to the other. A view from bank to bank is shown at the right.

The Communications Circuits Laboratory

### CMOS Transceivers for the 60-GHz Band

Professor Behzad Razavi, Director

The unlicensed band around 60 GHz presents the possibility of short-range communications at high data rates. The anticipated complexity of transceivers designed for operation in this band makes the use of CMOS technology attractive, especially if techniques such as beamforming and multiple-input-multiple-output (MIMO) signaling are considered.

Today's development of 60-GHz CMOS transceivers is reminiscent of the challenges that faced 5-GHz CMOS wireless LAN circuits in the mid-1990s: the intrinsic speed of the then-available transistors was inadequate, and no significant commercial value had been identified. Nonetheless, if 60-GHz transceivers follow the fate of their 5-GHz counterparts, both of these issues will be resolved in the near future.

Another critical attribute of communication at 60 GHz is the small wavelength and hence the possibility to integrate the antenna on-chip. While somewhat lossy, on-chip antennas offer several significant benefits. They (1) obviate the need for expensive and lossy millimeter-wave packaging, (2) lend themselves to differential operation, transmitting a greater power for a given voltage swing, and (3) eliminate lossy ESD protection devices. Addition-
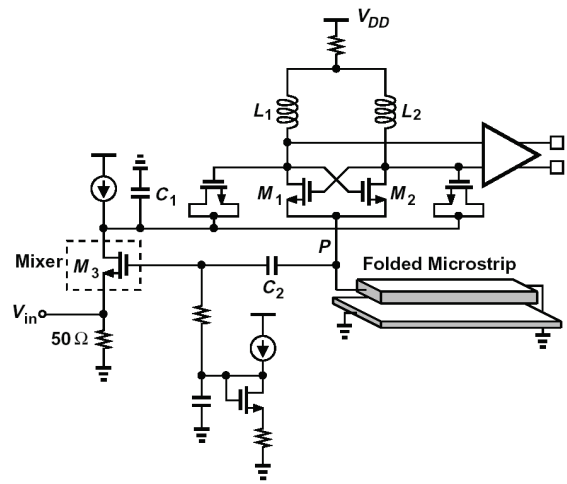
60-GHz CMOS Frequency Divider

ally, the receive and transmit paths can incorporate separate antennas to avoid the use of lossy transmit/receiver switches, and the transmitter need not be AC-coupled to the antenna. Finally, the antennas can serve in a beamforming array, raising the output power. This last property is particularly important because, with the low supply voltage of deep-submicron devices, it is much simpler to construct a multitude of low-power transmitters than one high-power counterpart.

The research on 60-GHz CMOS transceivers at UCLA has, in its first phase, concentrated on critical building blocks such as receiver and transmitter front ends and frequency dividers. Using new circuit topologies, the performance of these blocks is pushed to 60 GHz in 0.13-um CMOS technology. Shown above are the die photograph of the transmitter front end with an integrated dipole antenna and the circuit diagram of the 60-GHz frequency divider. The second phase aims toward higher levels of integration of these functions in 90-nm CMOS.
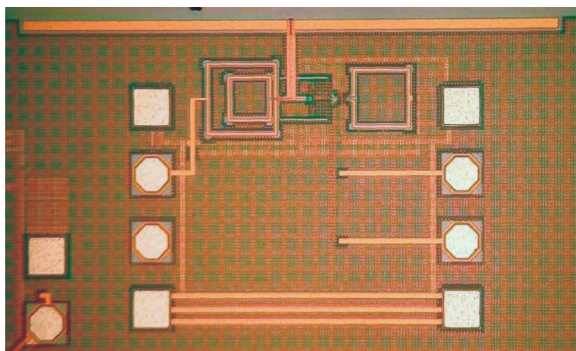
60-GHz CMOS Transmitter with On-chip Antenna
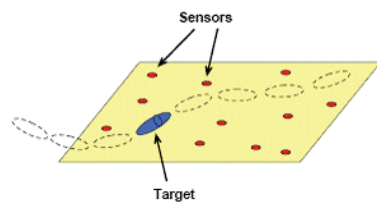
The Adaptive Systems Laboratory

Distributed Processing over Adaptive Networks

Professor Ali H. Sayed, Director

Distributed networks linking PCs, laptops, cell phones, sensors and actuators will form the backbone of future data, communication, and control networks. Applications will range from environment monitoring to disaster relief management, target localization, as well as medical applications. In all these cases, the distribution of the nodes in the field yields spatial diversity, which should be exploited alongside the temporal dimension in order to enhance the robustness and performance of the processing tasks.

Distributed processing is the discipline that deals with the extraction of information from data collected at geographically dispersed nodes. For example, each node in a network of nodes could collect noisy observations related to a certain parameter or phenomenon of interest (such as the location of a moving target). The nodes would then interact locally with each other, as dictated by the network topology, in order to arrive at an estimate of the parameter of interest. The objective is to arrive at an estimate that is as accurate as the one that would be obtained if each node had access to the information across the entire network. Since the nodes rely solely on their local data and on interactions with their immediate neighbors, the amount of processing and communications is significantly reduced in comparison to a centralized solution. Obviously, the effectiveness of any distributed implementation will depend on the modes of cooperation that are allowed among the nodes.

Keeping track of a moving target using a network of nodes

Professor Ali H. Sayed and the researchers in his laboratory have been working on developing distributed estimation algorithms that enable a network of nodes to function as an adaptive entity. The property of adaptation is funda-

Three modes of cooperation among distributed nodes
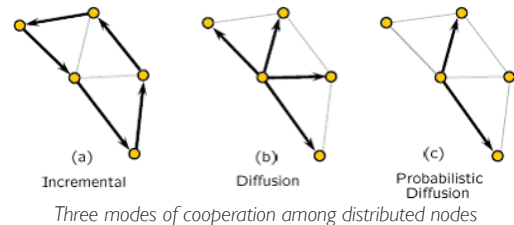
mental in order to (1) endow the network with real-time learning abilities, (2) implement robust schemes to spatio-temporal variations, and (3) limit local processing and communications needs. An adaptive network would be able to respond to spatial and temporal data in real-time by relying solely on local collaborations among neighboring nodes. In this way, whenever information arrives at a particular node, the information creates a ripple effect throughout the network and it influences the performance and behavior of the other nodes as allowed by the network topology. In designing such adaptive networks, there are several interesting issues to consider. One issue relates to the topology of the interacting nodes and the other issue relates to the processing and communications constraints imposed on the nodes. In addition, an adaptive network comprises a "system of systems" and the study of such systems is demanding due to the interactions among the nodes and their influences on each other. Results so far have yielded several adaptation techniques with encouraging performance levels.
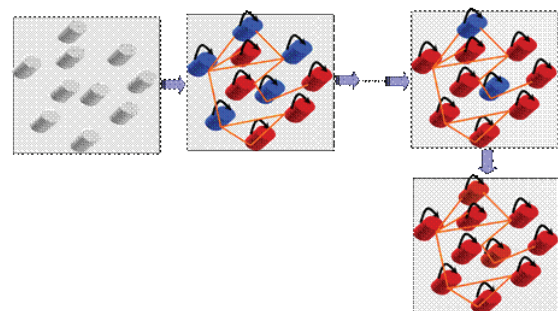
Adaptation and learning over a network of nodes

The Proactive MediaNet Laboratory

Reinventing Multimedia Communication Theory

Professor Mihaela van der Schaar, Director

Professor van der Schaar and the students in her laboratory are performing research in the general area of multimedia communication and networking, multimedia compression, modeling, processing, and multimedia systems. Their research focuses on three fundamental, necessary and related research thrusts aimed at making ubiquitous wireless multimedia applications and systems a reality:

1. Cross-layer design for multimedia communications and multi-user wireless multimedia communications based on economics principles
2. Theoretical foundations for designing and optimizing multimedia algorithms on resource-constrained systems
3. System and network constrained scalable video coding, processing and streaming

For instance, their research is aimed at addressing one of the most important challenges for multi-user wireless multimedia transmission: the performance of all existing resource allocation schemes heavily depends on the users declaring their requirements in a truthful manner. Particularly in a congested network, if some users exaggerate or lie about their rate requirements, the performance of the entire wireless network will degrade. Existing resource management solutions do not prevent wireless stations from exaggerating their resource needs at the expense of competing stations, and there is no incentive, other than the ultimate survival of the system, for users to limit their resource use. Hence, each user will try to acquire as much of the resources as possible (see e.g. resource allocation solutions based on IEEE 802.11e wireless standard), unless a preemptive mechanism exists in the network.

Researchers in the Proactive MediaNet Laboratory have been working on the above challenges by augmenting and reinventing (multimedia) communication theory, resource management, algorithms, and systems based on

Multi-user Video Streaming over Wireless Mesh Networks
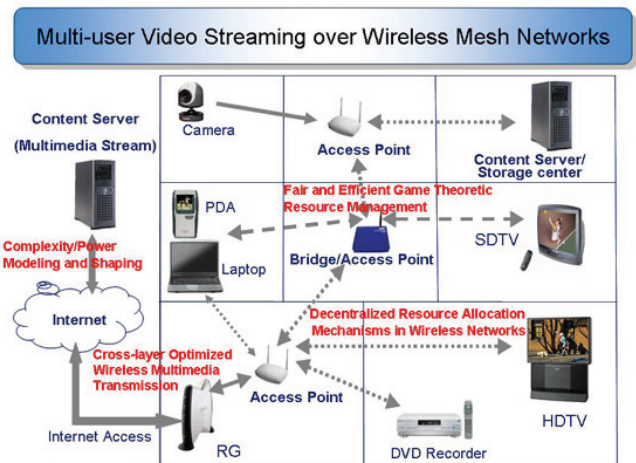
economics principles. This is achieved by remodeling existing passive resource allocation problems as economics-driven interactions among selfish users competing for a common network resource "market". They analyzed the outcome of various interactions among selfish users both in terms of dynamics and steady state equilibrium(s) and synthesized mechanisms that achieve new measures of optimality, rationality and fairness for multi-user communication systems. Game-theoretic principles and tools are combined with multimedia communication and signal processing algorithms to model, analyze and modify such interactions. For example, by modeling multimedia transmitters as rational players competing for available wireless network resources in a dynamic repeated game with incomplete information, new communication algorithms were developed to enable the proactive participation of stations in the resource exchange game. These algorithms jointly consider available resources, derived application utilities, user risk attitudes (determined by competitive analysis and available information about the time-varying resource "market"), and willingness to pay for resources.

Controlling the Spin of an Electron

Prof. E. Yablonovitch

A UCLA team of researchers succeeded in flipping a single electron spin upside down in an ordinary commercial transistor chip, and detected current change when the electron flips.

How does this translate into plain English? Electrical Engineering professor Eli Yablonovitch, who holds the Northrop Grumman Opto-Electronics Chair in Electrical Engineering, explains that "We have measured a single electron spin in an ordinary transistor. This means that conventional silicon technology is adaptable enough, and powerful enough, to accommodate the future electronic requirements of new technologies like quantum computing, which will depend on spin. We've done this with a commercial silicon integrated circuit chip, literally off a shelf. Silicon is the dominant technology of our time, and will remain so for some time. For those who think silicon has too many limitations, silicon technology is surprisingly adaptable, enough so to meet the futuristic requirements of the 21st century. In the electronics of the 21st century, we will manipulate single electron spins — not just the charge of the electron, but the spin of the electron."

Yablonovitch adds, "With 100 transistors, each containing one of these electrons, you could have the implicit information storage that corresponds to all of the hard disks made in the world this year, multiplied by the number of years the universe has been around. And why stop with 100 transistors?"
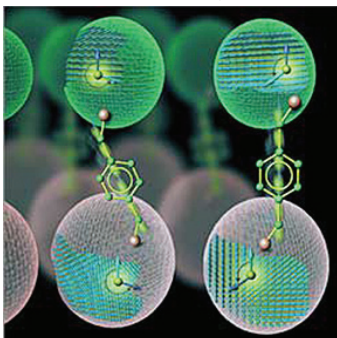
Simulation of manipulation of single electron spins (Image courtesy of CNSI, UC Santa Barbara)

This research makes quantum computing a closer and more practical reality. A single electron spin represents a quantum bit, the fundamental building block of a quantum computer. Quantum computing will use quantum physics to communicate much more securely; if someone tries to intercept a quantum message, the information would be destroyed.

Nanoscale Architectures

Prof. K.L. Wang

Electrical Engineering's Professor Kang Wang, Adjunct Professor Mary Eshaghian-Wilner, and researcher Alexander Khitun announced a critical new breakthrough in semiconductor spin-wave research: three novel nanoscale computational architectures using a technology they pioneered called "spin-wave buses" as the mechanism for interconnection. The architectures are power efficient and possess a high degree of interconnectivity.

The first device is a reconfigurable mesh interconnected with spin-wave buses. The architecture of the device requires the same number of switches and buses as standard reconfigurable meshes, but is capable of simultaneously transmitting multiple waves using different frequencies on each of the spin-wave buses. This makes the parallel architecture capable of very fast and fault-tolerant algorithms.

The second device is a fully connected cluster of functional units with spin-wave buses. Each node simultaneously broadcasts to all other nodes, and can receive and process multiple data concurrently. The novel design allows all nodes to intercommunicate in constant time. This invention overcomes traditional area restrictions found in current networks.

Third is a spin-wave-based crossbar for fully interconnecting multiple inputs to multiple outputs. As compared to standard molecular crossbar designs, UCLA's is much more fault-tolerant, allowing the reconfiguration of alternate paths in case of switch
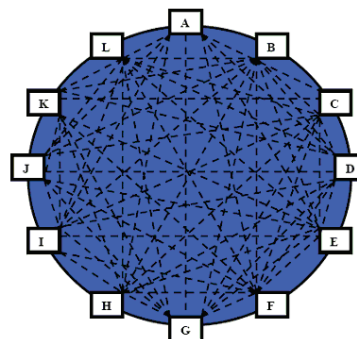
Figure representing a fully connected cluster of functional units with spin-waves

failure. By transmitting waves instead of traditional current charge transmission, the design architecture allows a large reduction in power consumption and provides a high level of interconnectivity between many more paths than currently possible.

Interdisciplinary Research Centers and Institutes

California NanoSystems Institute (CNSI)

The California NanoSystems Institute is a research center that is run jointly by UCLA and UC Santa Barbara. CNSI was established in 2000 with $100 million from the State of California and an additional $250 million in federal research grants and industry funding. Its mission is to encourage university collaboration with industry and enable the rapid commercialization of discoveries in nanosystems. In particular, CNSI is working to:

- establish a world-renowned center for nanosystems research and development
- develop commercial applications of CNSI's technology
- educate the next generation of scholars in nanosystems R&D
- promote regional development through commercial use of nanotechnology
- generate public appreciation and understanding of nanotechnology

CNSI members, who are on the faculty at UCLA and UCSB, represent a multi-disciplinary team of some of the world's preeminent scientists in the fields of materials science, molecular electronics, quantum computing, optical networking and molecular medicine, to cite but a few examples. Professors Eli Yablonovitch, Kang Wang, and Jack Judy of the Electrical Engineering Department are members of CNSI. Professor Yablonovitch is the Deputy Director of CNSI and Professor Wang heads the new Nanofab.
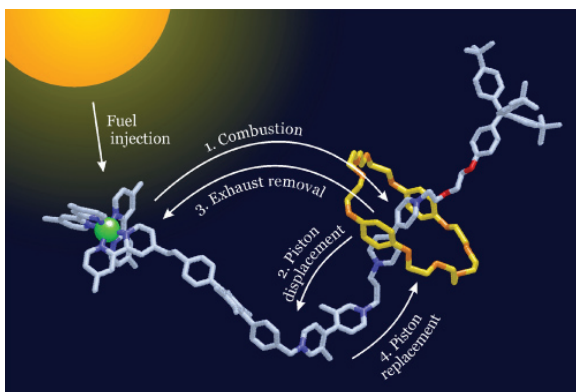
A nano motor powered by solar energy can work continuously without any external interference, and operates without consuming or generating chemical fuels or waste

Western Institute of Nanoelectronics (WIN)

WIN Team members (left to right) Prof. Kang L. Wang, Adjunct Prof. Mary Eshaghian-Wilner, and Dr. Alexander Khitun demonstrate the spin-wave setup in the WIN laboratory.

The Western Institute of Nanoelectronics is a multi-disciplinary center that is among the world's largest spintronics efforts. It is headquartered at UCLA and led by Electrical Engineering Professor Kang Wang. The institute involves collaborations among teams from UCLA, UC Santa Barbara, UC Berkeley, and Stanford. The program is co-managed by the four participating campuses and semiconductor industry sponsors, with nearly 10 researchers from semiconductor companies working with the students and faculty on all of the university campuses.

The institute's mission is to explore and develop advanced research devices, circuits and nanosystems with performance beyond conventional devices, which are based on the current industry standard, complementary metal oxide semiconductors. The Western Institute of Nanoelectronics is being established with starting grants of $18.2 million: an industrial support total of $14.38 million and a matching $3.84 million UC Discovery Grant. The $18.2 million includes $2.38 million from a Nanoelectronics Research Initiative grant funded by six major semiconductor companies — Intel, IBM, Texas Instruments, AMD, Freescale and MICRON. The amount also includes an additional Intel grant of $2 million. The institute also will receive a separate $10 million equipment grant from Intel.

Center for Embedded Networked Sensing (CENS)

CENS is pursuing fundamental science and engineering research needed to create scalable, robust, adaptive, sensor/actuator networks including both Embedded Networked Sensing (ENS) technology research and ENS applications research. ENS-facilitated education and outreach activities are intertwined with the technology and application development.


Prof. Deborah Estrin holds a sensor node developed at CENS.

Research is focused on four experimental application drivers: habitat monitoring for bio-complexity studies, spatially-dense seismic sensing and structure response, monitoring and modeling contaminant flows, and detection and identification of marine microorganisms. To support this scope, CENS continues to combine the expertise of faculty from diverse engineering disciplines with the expertise of biological, environmental and earth scientists. During the lifetime of the Center, additional opportunities for applying the technology to other natural and engineered systems will be pursued.

CENS is a $40M NSF Center directed by Prof. Deborah Estrin of the UCLA Computer Science and Electrical Engineering Departments. Electrical Engineering Professors Jack W. Judy, William J. Kaiser, Gregory J. Pottie, Mani B. Srivastava, John D. Villasenor, and Kung Yao contribute the resources of their research groups to the Center's goal.
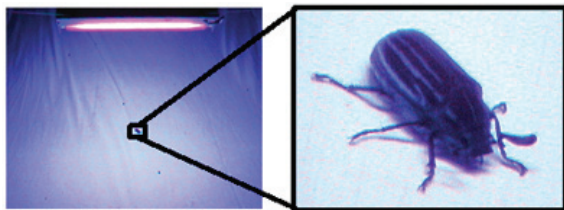
Resolution of a NIMS imager

Center on Functional Engineered Nano Architectures (FENA)
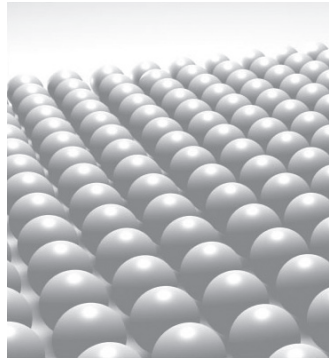
Simulation of nanostructured materials

FENA is a multi-disciplinary center that aims to create and investigate new nano-engineered functional materials and devices, and novel structural and computational architectures for new information processing systems beyond the limits of conventional CMOS technology. FENA is part of the Focus Center Research Program initiated by the Semiconductor Research Corporation in an effort to expand pre-competitive, cooperative, long-range applied microelectronics research at US universities. The center, which was established in 2003, will receive $13.5 million over the first three years, and as much as $70 million over 10 years.

FENA has 28 distinguished principal investigators from broad areas such as Materials Science, Chemistry, Electrical Engineering, Bio Engineering, Mathematics, Applied Physics, and Computer Engineering, from 11 of America's most elite research universities. The center is led by Professor Kang Wang of the Electrical Engineering Department. FENA embraces the current opportunity to create and explore the next generation of nanoscale semiconductor technology to the borders of ultimate CMOS and beyond: inventing the heterogeneous interfaces of new nanosystems, enabling a combination of biological and molecular functions, and revolutionizing the paradigms of information processing and sensing. These new nanostructured materials will provide the basis for the continued expansion of the semiconductor industry and the creation of new applications of monolithically integrated (CMOS, molecular and biomolecular) nanosystems. FENA involves faculty from several institutions including UCLA, UCSB, UC Riverside, UC Berkeley, USC, Caltech, Stanford, MIT, New York University, University of Minnesota, North Carolina State University, and SUNY.

Endowed Chairs

Professor **Deborah Estrin** of the UCLA Computer Science and Electrical Engineering Departments was selected to hold the **Jonathan B. Postel Chair in Computer Networking** in recognition of her ground-breaking research. This position was established by Dr. Postel's former colleagues to honor and recognize his extraordinary achievements in the networking field over the course of his 30-year career as a leading spokesman and architect of systematic organization in the rapidly growing online community. "Having worked with Jon Postel for many years as a researcher in his Computer Networks division, and as a member of the larger Internet research community, the Chair is particularly meaningful," says Prof. Estrin. She is also Director of the Center for Embedded Networked Sensing (CENS), an NSF Science and Technology Center. CENS is a major research enterprise developing wireless sensor systems and applying this revolutionary technology to radically transform critical scientific and societal applications. In 2003, Estrin was named one of Popular Science's Brilliant 10, an annual list of young scientists conducting ground-breaking work, for her research in embedded sensor networks and its applications in environmental monitoring.

Professor **Tatsuo Itoh,** **Northrop Grumman Chair in Microwave and Millimeter Wave Electronics,** is a pioneer in electromagnetic engineering for microwave and wireless components, and heads the UCLA EE Department Microwave Electronics Laboratory. The laboratory has been engaged in a number of research projects, ranging from theoretical investigation to practical implementation of various microwave-related topics. The laboratory is working on enhancing the capability of retrodirective array for automatic target tracking and communication. Prof. Itoh's group has accomplished several unique capabilities previously unavailable, including a retrodirective array that can be reconfigured from the retrodirective mode to a direct conversion receiver/transmitter. The laboratory has also spearheaded the research and development of microwave applications of metamaterial structures. Unlike other research efforts in the world working on this subject, Prof. Itoh and his group have invented a uniquely different approach that provides low loss broadband capability. They have developed many microwave components with unusual or unique capabilities, including an electronically controlled antenna with 180 degree coverage and a variable radiation pattern, a very compact directional coupler, dual band circuits for high power high efficiency amplifiers, etc. A spin-off project is the development of small antennas for wireless communication (ten times smaller than conventional antennas).
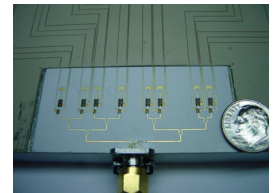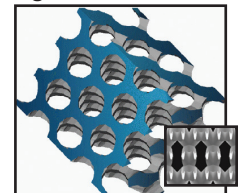
8-Antenna Millimeter-Wave Radar Receiver with Performance of 12 Antennas

Professor **Eli Yablonovitch**, a pioneer in the field of opto-electronics and photonic bandgap research, is the **Northrop Grumman Chair in Optoelectronics.** He also heads the UCLA EE Department Optoelectronics Group, which is focused on the future of electronics and optoelectronics. Among the technological changes that will be forthcoming in the near future are:

1. The full integration of optics and electronics in silicon chips. This is being accomplished in part by the incorporation of two-dimensional photonic crystal concepts into silicon design. An example of a three dimensional photonic crystal is in the figure at right, which is the electromagnetic analog of a conventional crystal for electrons.

A 3D photonic crystal (above), with an example of a side view (inset)

2 New paradigms for very-short-distance intra-chip communications will have to be developed, before we can create nano-electronics. Current signaling schemes consume too many joules per bit, dissipating the advantage of going to the nanoscale. A new short distance communications paradigm must emerge, so that the energy efficiency of nano-storage and nano-logic will be matched by equally efficient communications.

3. After the culmination of the current semiconductor road map, quantum information processing will emerge as dominant information processing technology of the 21st century. It is currently unclear which quantum information technology will emerge as dominant, but the Yablonovitch group is emphasizing semiconductor hosts for the qubits.

DR. HENRY SAMUELI

B.S. UCLA Electrical Engineering, 1975
M..S. UCLA Electrical Engineering, 1976
Ph.D. UCLA Electrical Engineering, 1980

"I have spent a good portion of my life affiliated with UCLA – as an undergraduate student, a graduate student, a faculty member, an industrial partner, and as a benefactor" says Dr. Henry Samueli. "The research I did as a faculty member formed, to a large extent, the foundations upon which we built Broadcom in the early days."

Founded in 1991, Broadcom is a global leader in providing semiconductor solutions for wired and wireless communications. Dr. Samueli is responsible for driving the vision of Broadcom's research and development activities as well as helping coordinate corporate-wide engineering development strategies. Broadcom had revenues of $2.7 billion in 2005 and employed 4,300 people worldwide at year-end, including over 150 UCLA alumni.

Dr. Samueli's outstanding career includes a professorship in the Electrical Engineering Department at UCLA, where he supervised research programs in broadband communications circuits and digital signal processing. He is a Distinguished Adjunct Professor in the Electrical Engineering and Computer Science Department at UC Irvine since 2003. In addition, Dr. Samueli, a named inventor in 36 U.S. patents, was Chief Scientist and one of the founders of PairGain Technologies, Inc., a telecommunications equipment manufacturer in the digital subscriber line (DSL) industry. He was a consultant for PairGain from 1988 to 1994 and held various engineering management positions in the Electronics and Technology Division of TRW, Inc. At TRW, Inc., he was responsible for the development of military broadband communications systems.

Dr. Samueli serves on the UC President's Board on Science and Innovation and is Chair of the UCLA Chancellor's Competitiveness Council. He is on the Board of Trustees of the UC Irvine Foundation and is a member of the UC Irvine Chief Executive Roundtable. He is on the Industrial Advisory Boards of the Henry Samueli School of Engineering and Applied Science at UCLA and the Henry Samueli School of Engineering at UC Irvine. In 2000, the University of California awarded him the Presidential Medal, the UC Irvine Medal, the IEEE Circuits and Systems Society Industrial Pioneer Award, and the UCLA School of Engineering and Applied Science Alumnus of the Year Award. Dr. Samueli's elections include Fellow of the Institute of Electrical and Electronics Engineers (IEEE) in 2000, a member of the National Academy of Engineering in 2003, and a Fellow of the American Academy of Arts and Sciences in 2004. In 2005, he received an Honorary Doctor of Science degree from the Technion-Israel Institute of Technology, and the Edward A. Dickson Alumnus of the Year Award from UCLA. Dr. Samueli has published over one hundred technical papers.

The success of Broadcom Corporation has provided Henry and his wife Susan the opportunity to support many worthwhile nonprofit organizations. Since Broadcom's initial public offering in 1998 the Samueli Foundation has granted over $180 million in gifts in the areas of Education, Health, Social Services, Spirituality & Interfaith, and the Arts. In 2003 and 2004 they were listed among Business Week's 50 Most Generous Philanthropists in the nation. "We fund numerous graduate research projects and we actively recruit UCLA Electrical Engineering Department graduates, because we feel they are the best trained students in our required specialties of any university we work with."
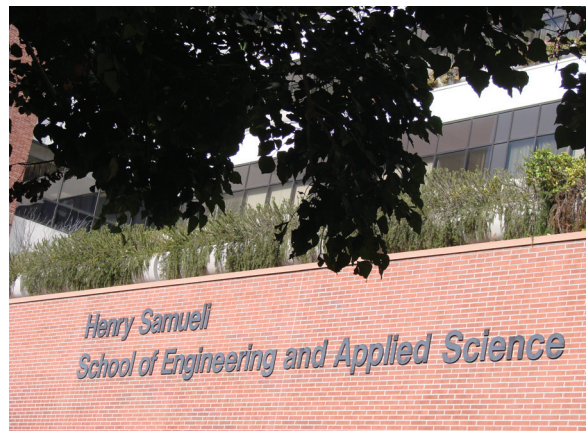
Honoring Dr. Samueli, the School was dedicated as the UCLA Henry Samueli School of Engineering and Applied Science in October 2000.

13

DR. DONALD STREIT

M.S., UCLA Electrical Engineering, 1983
Ph.D., UCLA Electrical Engineering, 1986

Dr. Dwight Streit is Vice President, Electronic Technologies, for Northrop Grumman Space Technology in Redondo Beach, California, where he is responsible for the development of advanced technology for microelectronics, communication systems and satellite payloads.

Dr. Streit received his M.S. and Ph.D. degrees in electrical engineering from UCLA in 1983 and 1986. He received his B.S. degree with a dual major in electrical engineering and chemistry from California State University, Los Angeles, in 1980. He is a member of the Tau Beta Pi, Eta Kappa Nu and Sigma Xi honor societies. He is also a member of the National Academy of Engineering and the NASA Space Technology Hall of Fame, and is a Fellow of the Institute of Electrical and Electronics Engineers and the American Association for the Advancement of Science. He currently serves on advisory boards for the Air Force Research Laboratory, the Army Research Laboratory and the National Research Council. He is the recipient of numerous awards, including the Northrop Grumman Distinguished Innovator Award, five TRW and two Northrop Grumman Distinguished Patent Awards, six TRW Chairman's Awards for Innovation and two TRW CEO Leadership Awards. He has received several best-paper awards at major international conferences, and has over 300 technical publications with some 30 patents issued or pending.

Dr. Streit also serves as Northrop Grumman's executive liaison to the UCLA Henry Samueli School of Engineering. "UCLA is one of the top engineering schools in the country, and we at Northrop Grumman are fortunate to have an excellent, long-standing relationship with the school", he says. "The number of UCLA engineering firsts is truly remarkable. Our strong relationship with UCLA is highly valued, and I am very happy to be able to interact and work with the school on a regular basis. Not only do we hire a significant number of outstanding engineers and scientists from UCLA, we are also team members on a number of high-technology development contracts that have provided great benefit to UCLA, Northrop Grumman, and the nation as a whole."

DR. ARMOND HAIRAPETIAN

B.S., UCLA Electrical Engineering, 1987
M.S., UCLA Electrical Engineering, 1988
Ph.D., UCLA Electrical Engineering, 1993

When you walk through the Hairapetian Graduate Student Center, in the Electrical Engineering department, you see rows of workspaces that are new, quiet, and private.

The center is the kind of setting engineering students need for their periods of intense study and exchange of ideas. The old center, used extensively by Dr. Hairapetian, a three-time electrical engineering alumnus, (BS '87, MS '88, and PhD '93), was on its last legs.

"It's important to have an environment in which students can gather and talk to each other," noted Hairapetian. "Making a gift to pay for the renovation is a good investment in the future. UCLA is a place that produces talented engineers, and for the state to stay competitive, you need to attract great students to produce top-notch engineers."

Alongside this UCLA legacy stands his ground-breaking engineering inventions.

Dr. Hairapetian developed the world's first 10Gbit/sec transceivers in CMOS. These products are now the industry's benchmark and are used in the majority of 10G optical transmission systems.

Dr. Hairapetian has more than 15 years of technical and general management experience in the area of analog, RF and mixed-signal integrated circuits. He was the General Manager of the optical products division of Broadcom Corporation, the leading supplier of 10G transceiver ICs for optical communications. Armond was the co-founder and CEO of NewPort Communications where he led the engineering effort in developing the world's first OC-48 and OC-192 transceivers in CMOS, and the ultimate sale of the company to Broadcom in August 2000 for approximately $1.2 billion.

Currently, Dr. Hairapetian is Vice President and Entrepreneur in Residence of Miramar Venture Partners, serves as CEO and is on the Board of Starport Systems, a Miramar portfolio company.

## Robert S. Elliott – National Academy of Engineering

Professor Emeritus Robert S. Elliott has had a long and illustrious career at UCLA. He served as the first Electrical Engineering Department Chair in the (then) School of Engineering and Applied Science and was the first person to hold the Hughes Distinguished Chair in Electromagnetics at UCLA. He became a Fellow of the IEEE in 1961, and was the recipient of the APS Distinguished Achievement Award in 1988. Also in 1988, and even more importantly, Dr. Elliott was honored by the National Academy of Engineering "for basic contributions to the electromagnetic theory and design of array antennas, and for outstanding leadership in engineering education". During his career at UCLA Prof. Elliott also was the recipient of a half-dozen Best Teacher Awards, two Best Paper Awards from IEEE; he was elected to Tau Beta Pi, Sigma Xi, and the New York Academy of Sciences. In 2000 he received an IEEE Third Millennium Medal. Dr. Elliott is also the author of two seminal electrical engineering textbooks, *Antenna Theory and Design* (now in a reissued, revised edition) and *Electromagnetics*.

Tatsuo Itoh – National Academy of Engineering

Professor Itoh has pioneered a research area in interdisciplinary electromagnetics beyond traditional electromagnetic engineering. Elected to the National Academy of Engineering in 2003, his citation reads, "For seminal contributions in advancing electromagnetic engineering for microwave and wireless components, circuits, and systems". In his early career, he developed a number of numerical methods for microwave problems. Based on one of these methods, he then developed the first CAD program package for design of E-plane filters for millimeter wave systems such as radio, radar, and remote sensors. More recently, his effort has been directed to coherently combining solid state devices and electromagnetic circuits for improved cost effectiveness and system performance. From this effort, the first global simulator for the RF frontend was developed, dealing with antennas, passive and active microwave circuits at the same time. He has also created the Active Integrated Antenna scheme in which the antenna is not only a radiating element but also serves as a circuit element for the RF front end, particularly at millimeter wave frequencies.

Stanley Osher – National Academy of Sciences
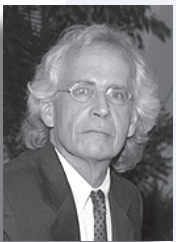
Professor Osher received his MS and PhD (1966) from the Courant Institute, NYU. After working at Brookhaven National Laboratory, UC Berkeley and SUNY Stony Brook, he has been at UCLA since 1976. He is Director of Special Projects at the Institute for Pure and Applied Mathematics at UCLA. Dr. Osher is the co-inventor of a) level set methods for computing moving fronts (182,000 references on Google); b) ENO, WENO and other numerical methods for computing solutions to hyperbolic conservation laws and Hamilton-Jacobi equations; and c) total variation and other PDE based image processing techniques. He has been a Fulbright and Alfred P. Sloan Fellow, received the NASA Public Service Group Achievement Award, Japan Society of Mechanical Engineers Computational Mechanics Award, was an invited speaker at the International Congress of Mathematicians, received the SIAM Pioneer Prize at the last ICIAM conference, and the SIAM Kleinman Prize at the last SIAM national meeting. In May 2005, Professor Osher was elected to the US National Academy of Sciences for "major contributions to algorithm development and applications in level set methods, high-resolution shock capturing methods, and PDE-based methods in imaging science. His work is used widely throughout engineering and science." Dr. Osher has also cofounded 3 successful companies, based, in part, on his own research. His work has been written up numerous times in the scientific and international media, e.g., *Science News* and *Die Zeit*. He is a highly cited researcher, and is the Associate Editor of a number of major journals.

Members of the National Academies

C. Kumar Patel – National Academy of Sciences, National Academy of Engineering

Professor Patel holds a joint professorship with the Electrical Engineering and Physics Departments at UCLA. Until March 1993, he was executive director of the Research, Materials Science, Engineering and Academic Affairs at AT&T Bell Laboratories. While at AT&T, he made numerous seminal contributions in several fields, including gas lasers, nonlinear optics, molecular spectroscopy, pollution detection and laser surgery. He has received numerous honors, including the National Medal of Science, for his invention of the carbon dioxide laser. He has also received the Lomb Medal of the Optical Society of America, the Franklin Institute's Ballantine Medal, the Pake Prize of the American Physical Society, and the Coblentz Society's Coblentz Prize. He co-chaired the American Physical Society study of the science and technology of directed energy weapons. He also is past vice chancellor of research at UCLA.

Henry Samueli – National Academy of Engineering

Dr. Henry Samueli was elected to the NAE in recognition of his "pioneering contributions to academic research and technology entrepreneurship in the broadband communications system-on-a-chip industry. Dr. Samueli has over 25 years of experience in the fields of digital signal processing (DSP) and communications systems engineering. He is widely recognized as one of the world's leading experts in the field of broadband communications circuits. He received his BS, MS and PhD degrees in electrical engineering from UCLA. Since 1985, Dr. Samueli has been a professor in the Electrical Engineering Department where he has supervised advanced research programs in DSP and broadband communications. Well known as the cofounder of Broadcom Corporation in 1991, Samueli continues to contribute his expertise and support of both the Department and the School, which was named in his honor in October 2000.

Jason Speyer – National Academy of Engineering

Professor Speyer, who holds a joint professorship with the UCLA Electrical Engineering and the Mechanical and Aerospace Engineering Departments, was elected to the National Academy of Engineering for "the development and application of advanced techniques for optimal navigation and control of a wide range of aerospace vehicles." He has pioneered new optimal deterministic and stochastic control, team and differential game strategies, estimation, and model-based fault detection, identification, and reconstruction theories and algorithms, and successfully developed and applied matrix calculus of variations to the Apollo autonomous navigation system. He pioneered the development and mechanization of periodic optimal control with applications to aircraft fuel-optimal cruise and endurance. He was the first to apply modern control syntheses to a fielded system. His efforts in differential carrier phase GPS blended with an inertial navigation system was applied to formation flight for drag reduction and achieved centimeter accuracy in flight test on two F-18s. Dr. Speyer is a fellow of AIAA and IEEE (Life Fellow) and was awarded the AIAA Mechanics and Control of Flight Award, the AIAA Dryden Lectureship in Research, the Air Force Exceptional Civilian Decoration, and the IEEE Third Millennium Medal.

Eli Yablonovitch -- National Academy of Engineering, National Academy of Sciences

Professor Eli Yablonovitch was elected as a member of the NAE "for introducing photonic bandgap engineering and applying semiconductor concept to electromagnetic waves in artificial periodic structures". An integral component of these accomplishments is the photonic crystal. "Photonic crystals are being used as one of the design paradigms for forthcoming photonic integrated circuits. In addition, they lead to the smallest electromagnetic cavities with the highest Q-factors, and are now used in many quantum information devices. Interestingly, these photonic crystal structures that were discovered by analogy with semiconductors are now recognized to occur in Nature, and are responsible for some of the brilliant colors in the animal world, including peacocks and parrots. In the same year that he was elected to the National Academy of Engineering (2003), Prof. Yablonovitch was also elected to the National Academy of Sciences, "for field-opening contributions to quantum electronics and photonic materials, including the invention of the photonic bandgap, photonic crystals, and the strained quantum well laser."

Electromagnetic Metamaterials: Transmission Line Theory and Microwave Applications

### Christoph Caloz and Tatsuo Itoh   *Wiley-IEEE Press, 2005*
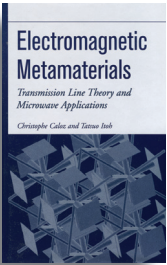
This book presents an original generalized transmission line approach associated with non-resonant structures that exhibit larger bandwidths, lower loss, and higher design flexibility. It is based on the novel concept of composite right/left-handed (CRLH) transmission line metamaterials (MMs), which has led to the development of novel guided-wave, radiated-wave, and refracted-wave devices and structures. The authors introduced this powerful new concept and are therefore able to offer readers deep insight into the fundamental physics needed to fully grasp the technology. Moreover, they provide a host of practical engineering applications. *Electromagnetic Metamaterials* connects the more theoretical nature of negative index materials to the practical, and covers all of the important topics relevant to a very complete description of the transmission line model of negative index materials.

Fundamentals of Microelectronics

Behzad Razavi   *John Wiley and Sons, 2006*

This textbook teaches undergraduate microelectronics from a modern and intuitive perspective. While emphasizing analysis and design of circuits, the book also provides the device physics foundation that is necessary in today's semiconductor industry. Developed for both quarter and semester systems, the book draws upon the author's industrial, research, and teaching experience to impart analysis and design principles. Offering a fresh new approach to teaching and learning microelectronics, *Fundamentals of Microelectronics*, Preview Edition, helps students develop intuitive techniques to the design and implementation of discrete and integrated circuits. Razavi relates modern circuit design from a practical perspective, combined with a sense of excitement that captures the importance of today's microelectronics.
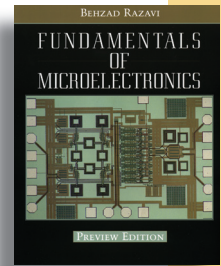
Matrix Analysis for Scientists and Engineers

Alan J. Laub   *SIAM Press, 2005*
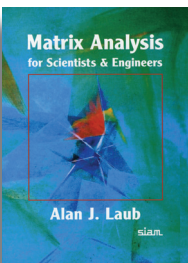
Because the tools of matrix analysis are applied on a daily basis to problems in biology, chemistry, econometrics, engineering, physics, statistics, and a wide variety of other fields, the text can serve a rather diverse audience. *Matrix Analysis for Scientists and Engineers* is primarily intended to be used as a text for senior undergraduate or beginning graduate students who wish to be familiar enough with matrix analysis and linear algebra that they can effectively use the tools and ideas of these fundamental subjects in a variety of applications. However, individual engineers and scientists who need a concise reference or a text for self-study will also find this book useful.

Principles of Embedded Networked Systems Design

Gregory Pottie and William Kaiser   *Cambridge University Press, 2005*

This book details the fundamentals for the interdisciplinary and fast-moving field of embedded network systems (ENS). It begins with mathematical foundations and the relevant background topics in signal propagation, sensors, detection and estimation theory, and communications. Key component technologies in ENS are discussed: synchronization and position localization, energy and data management, actuation, and node architecture. Ethical, legal, and social implications are addressed. A focus on fundamental principles together with extensive examples and problem sets make this text ideal for use in graduate courses on electrical engineering and computer science. It will also appeal to engineers involved in the design of ENS.
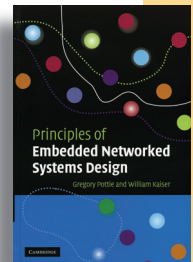
Seminars, Workshops, and Research Reviews

Seminar Series in Electrical Engineering

During the academic year 2005-2006, the department was pleased to host a number of outstanding researchers covering a broad range of topics.

Fall 2005 (Signals and Systems Area)
Professor A. Alwan, organizer

- R. **Stern** (Carnegie Mellon University): *New Directions in Robust Automatic Speech Recognition*
- A. **Hero** (University of Michigan): *Manifold Learning for Detection and Localization in Sensor Networks*
- R. **Gray** (Stanford University): *Quantization, Compression, and Classification*
- J. **Beutal** (ETH Zurich): *BT Nodes: Design and Deployment of Wireless Networked Embedded Systems*
- A. **Sayeed** (University of Wisconsin): *Wireless Communication and Sensing in Time, Frequency, and Space*
- A. **Orlitsky** (UC San Diego): *Information Theory and Probability Estimation*
- S. **Savari** (University of Michigan): *On Networks of Two-Way Communication Channels*
- M. **Medard** (Massachusetts Institute of Technology): *Wireless Network Coding*

Winter 2006 (Circuits and Embedded Systems Area)
Professor S. Pamarti, organizer

- R.A. **Rutenbar** (Carnegie Mellon University): *Probabilistic Interval-Valued Computation*
- G. **Temes** (Oregon State University): *Incremental Delta-Sigma A/D Converters*
- R. **Sarpeshkar** (Massachusetts Institute of Technology): *Bioelectronics*
- P. **Ramanathan** (Univ. of Wisconsin): *Exploiting Mobility for Collaborative Decision-Making in Sensor Networks*
- J. **Rabaey** (UC Berkeley): *Traveling the Wild Frontiers of Ultra Low-Power Design*
- P. **Heydari** (UC Irvine): *Design of Novel Integrated Circuits (ICs) for Broadband Wireless/Wireline Communication*
- G. **Borriello** (University of Washington, Seattle): *Personal Sensors for Personal Health*

Spring 2006 (Physical and Wave Electronics Area)
Professor H. Fetterman, organizer

- E. **Yablonovitch** (UCLA): *CMOS Integrated Nanophotonics Is Now a Commercial Technology*
- N. **Engheta** (University of Pennsylvania): *Metamaterials, Shrinking Circuit Elements, and Nanooptics*
- S. **Brueck** (University of New Mexico): *Phat Photons for Nifty Nanoscience*
- D. **Dapkus** (USC): *InGaAs/InGaAsP/InP Quantum Dot Lasers Operating CW at Room Temperature*
- P. **Kim** (Columbia): *Electric Field Effect Control of Low-Dimensional Transport Phenomena in Nano Materials*
- R. **Byer** (Stanford University): *Acceleration of Electrons with Visible Light*
- D. **Gottesman** (Perimeter Institute for Theoretical Physics, Canada): *Correcting Quantum Errors*

Integrated Circuits and Systems Industry Research Review

The Integrated Circuits and Systems faculty and students held their annual research review in Winter 2006 to demonstrate their latest developments to industry sponsors.

Professor C.K. Ken Yang, organizer
February 13, 2006

- T. Kaplan and M.C.F. **Chang**: *A 2-GS/s 3-bit Delta-Sigma Modulated DAC with Tunable Bandpass Mismatch Shaping*
- M. Aboudina and B. **Razavi**: *A 14-Bit High-Speed CMOS Oversampling A/D Converter*
- L. Luu and B. **Daneshrad**: *Relaxing RF Component Requirements in a Weaver Architecture by Learning and Adapting to the Environment*
- G. Zhong, F. Xu, and A.N. **Willson, Jr.**: *A Power-Scalable Reconfigurable FFT/IFFT IC Based on a Multi-Processor Ring*
- D. Huang and M.C.F. **Chang**: *60GHz VCO with Artificial Dielectric Embedded Resonator On-Chip for Noise, Power, and Size Reduction*
- C.-W. Yao and A.N. **Willson, Jr.**: *A Phase-Noise Reduction Technique for Quadrature LC-VCO with Phase-to-Amplitude Noise Conversion*
- L. Lee and C.K.K. **Yang**: *A Sub-10ps Multi-Phase Sampling System Using a Redundancy-based Technique*
- C.T. Chou and S. **Pamarti**: *Common Mode Signaling at Gb/s Data Rates*
- S. Kim, I. Verbauwhede, and M.C.F. **Chang**: *A Low Power Pulsed Signaling Transceiver for a Fully AC Coupled Bus*
- S. Gondi and B. **Razavi**: *A 10-Gb/s CMOS Merged Equalizer/Clock Recovery Circuit*
- J. Kim, H. Hatamkhani and C.K.K. **Yang**: *An 8-Gb/s Transformer-Boosted Transmitter with VDD Swing*
- R. Bagheri, A. Mirzaei, S. Chehrazi, M. Heidari, M. Lee, M. Mikhemar, W. Tang, and A. **Abidi**: *An 800 MHz to 5 GHz Software-Defined Radio Receiver in 90nm CMOS*
- A. Parsa, M. Manteghi, Y. **Rahmat-Samii**, and B. **Razavi**: *A Millimeter-Wave CMOS Transmitter Front End with Integrated Antenna*
- M. Chen, Y. Wu, and M.C.F. **Chang:** *Active Second-Order Intermodulation Calibration for Direct-Conversion Receivers*

Electrical Engineering Workshop on Wireless Multimedia Systems

Every year the department is pleased to sponsor focused workshops on topics of heightened interest with the participation of faculty, students, industry and invited speakers.

Professor Mihaela van der Schaar, organizer
May 11-12, 2006

- T. **Chen** (Carnegie Mellon University): *Content-Aware Adaptive Retry for Media Streaming Over Wireless Networks*
- P. **Cosman** (University of California, San Diego): *Visibility of Packet Losses in H.264 Video*
- B. **Girod** (Stanford University): *Network Adaptive Video Streaming*
- Y.H. **Hu** (University of Wisconsin, Madison): *Wireless Video Communication for Sensor Network Applications*
- C.J. **Kuo** (University of Southern California): *Technologies for Decoder-Friendly Embedded Multimedia Systems*
- A. **Ortega** (University of Southern California): *Model Estimation for Distributed Source Coding*
- G.J. **Pottie** (University of California, Los Angeles): *In-Network Processing in Sensor Networks: Keeping It Local*
- H. **Radha** (Michigan State University): *Utility and Limitations of Side-Information for Wireless Multimedia*
- K. **Ramchandran** (Univ. of California, Berkeley): *Video Transmission Based on Distributed Source Coding Principles*
- I. **Rubin** (University of California, Los Angeles): *Backbone Synthesis, Routing and Medium Access Control for Autonomous Multimedia Ad Hoc Wireless Communications and Sensor Networks*
- M. **van der Schaar** (University of California, Los Angeles): *New Game-Theoretic Paradigm for Wireless Multimedia Communication with Resource and Information Exchanges*

Faculty Awards

Faculty Achievement Awards

Harold Fetterman, with his colleagues William Steier and Lawrence Dalton, was awarded the 2006 IEEE LEOS William Streifer Scientific Achievement Award for his seminal work with polymer photonic devices and materials. Over the past decade, this group revolutionized the field of polymer photonics. Awarded annually, the Streifer award is the highest award to be given by the Lasers and Electro-optics Society of IEEE.

Chand Joshi was awarded the 2006 Maxwell Prize by the American Physical Society. This is the highest award given by the APS for plasma physics research. Prof. Joshi is a pioneer in the area of plasma-based accelerators and laser-plasma interactions and this award acknowledges his many ground-breaking accomplishments, developed from the ground up at UCLA's Electrical Engineering Department.

Faculty Recognitions

Deborah Estrin, who holds a joint appointment with the UCLA Computer Science Department and the UCLA Electrical Engineering Department, was chosen as the recipient of the first Association for Computing Machinery's Athena Lecturer Award.

Bahram Jalali and his former student **Ozdal Boyraz** were named among *Scientific American*'s prestigious annual "Scientific American 50" list for their innovative work with silicon lasers. The list recognizes key science and technology contributions.

Jia-Ming Liu was chosen to receive a prestigious 2006 Guggenheim Fellowship, among the most coveted honors accorded to scholars, artists and writers. The Fellowship, awarded by the John Simon Guggenheim Memorial Foundation, is conferred for "unusually distinguished achievement and exceptional promise for future accomplishment." Prof. Liu will use his Guggenheim Fellowship to conduct research on three-dimensional intracellular laser nanoscopy – using lasers to see structures inside a cell with a resolution on the scale of only nanometers.

Yahya Rahmat-Samii received a NASA Inventions and Contributions Board Award for "Fan Beam Patterns Radiated from a Parabolic Reflector Antenna." Awards are given in recognition of contributions to the National Space Program, and to the mission of the Jet Propulsion Laboratory.

Mihaela van der Schaar received the 2005 IBM Faculty Award in recognition of the quality of her research on new video streaming techniques and fairness policies for real-time multimedia transmission over enterprise networks to industry.

Best Paper Awards

The IEEE Signal Processing Society awarded a 2005 Young Author Best Paper Award to **W. Younis**, **A.H. Sayed**, and **N. Al-Dhahir** for their paper "Efficient Adaptive Receivers for Joint Equalization and Interface Cancellation in Multiuser Space-Time Block-Coded Systems" (*IEEE Transactions on Signal Processing*, 51(11): 2849-2862, November 2003).

M. van der Schaar received the 2006 IEEE Circuits and Systems Society Transactions on Circuits and Systems for Video Technology Best Paper Award for the paper "Complexity Scalable Motion Compensated Wavelet Video Encoding (*IEEE Transactions on Circuits and Systems for Video Technology*, 15(8):982-993, August 2005), co-authored with D. Turaga and B. Pesquet-Popescu.

Student Awards

- The 2006 ACM/IEEE International Symposium on Physical Design, a conference on VLSI design automation, granted a **Best Paper Award** to Professor **L. He**, graduate researcher **J. Xiong**, and IBM Research Lab research collaborator **V. Zolotov**, for their paper, "Robust Extraction of Spatial Correlation" *(Proceedings of 2006 IEEE/ ACM International Symposium on Physical Design,* pp. 2-9).

- UCLA Engineering's Iota Gamma Chapter of Eta Kappa Nu, the electrical and computer engineering honor society, was selected as a recipient of the **Outstanding Chapter Award (OCA) for 2004-05**. Electrical Engineering Professor Alan N. Wilson, Jr. is the advisor for the UCLA Chapter. The OCA is a mark of significant distinction for a college chapter. The award was presented to Electrical Engineering Professor **Ali H. Sayed**, on behalf of the UCLA Chapter, at the Electrical and Computer Engineering Department Heads Association Annual Meeting banquet held in Hawaii in March 2006.

- The paper "Demonstration of Uncoordinated Multiple Access in Optical Communications," was awarded **first place at the Student Design Contest (**System Category), jointly organized by the 2006 ACM Design Automation Conference and the 2006 IEEE International Solid-State Circuits Conference. The paper was co-authored by **H. Chan, A. Vila Casado, J. Basak, M. Griot, W. Weng**, and electrical engineering professors **Richard Wesel, Bahram Jalali, Eli Yablonovitch,** and **Ingrid Verbauwhede.**

- 2006 Outstanding Student Awards:

Christina Huang Memorial Prize	A.N. El Naga (BS)	**Henry Samueli Excellence in Teaching Award**	N. Khajehnouri S. Panchapagesan
Outstanding Senior Award	C. Gomez (BS)	**HSSEAS Outstanding Bachelor of Science Award**	A.N. El Naga C. Gomez
Outstanding MS Awards	B.J. Borgstrom (Advisor, *A. Alwan*) F. Chiang (Advisor, *J. Judy*)	**Harry M. Showman Prize:**	K. Geary
Outstanding PhD Awards	A. Tarighat (Advisor, *A.H. Sayed*) J. Xiong (Advisor, *L. He*)	**Engineering Achievement Award for Student Welfare**	A.N. El Naga

Professor Sayed with Outstanding B.S. Student A.N. El Naga and his parents at commencement

Chi-On Chui
(Physical and Wave Electronics Area)
Assistant Professor
Ph.D. Stanford University, 2004

Heterostructure semiconductor devices and technology involving the application of novel device concepts and fabrication techniques to explore the quantum and strain effects at the nanoscale.

Paulo Tabuada
(Signals and Systems Area)
Assistant Professor
Ph.D. Technical University of Lisbon, Portugal, 2002

Design of networked embedded control systems. Modeling, analysis and design of discrete-event, timed and hybrid systems. Hierarchical and distributed control design, geometric and algebraic control theory for nonlinear and Hamiltonian control systems, categorical systems theory.

Dejan Markovic
(Circuits and Embedded Systems Area)
Assistant Professor
Ph.D. UC Berkeley, 2006

Power/area-efficient digital integrated circuits, VLSI architectures for wireless communications, optimization methods and supporting CAD flows.

Mihaela van der Schaar
(Signals and Systems Area)
Assistant Professor
Ph.D. University of Technology, Eindhoven, Netherlands, 2001

Theory and design of novel algorithms, standards and systems for multimedia coding, processing and ubiquitous communication over Internet and wireless networks.

Christoph Niemann
(Physical and Wave Electronics Area)
Assistant Professor
Ph.D. University of Technology, Darmstadt, Germany, 2002

Laser-plasma interactions, high-energy density physics, and inertial confinement fusion.

Benjamin Williams
(Physical and Wave Electronics Area)
Assistant Professor
Ph.D. Massachusetts Institute of Technology, 2003

Quantum cascade lasers in the terahertz frequency range, and the development of terahertz components based of subwavelength dimension for use in beam control, sensing, and imaging. Development of intersubband and intersublevel based devices in low-dimensional nanostructures for electronic and optoelectronic applications.

Adjunct Professors
N.G. Alexopoulos
E.R. Brown
C. Chien
M. Eshaghian-Wilner
G. Franceschetti
B. Houshmand
B. Kolner
W.H. Mangione-Smith
J.N. Schulman
M.C. Wu

Emeriti Professors
F.G. Allen
F.F. Chen
R.S. Elliott
F.W. Schott
D.M. Wiberg
J. Willis

Asad A. Abidi, *Area Director*
Ph.D. UC Berkeley, 1981

CMOS RF design, high speed analog integrated circuit design, data conversion, and other techniques of analog signal processing.

- Fellow, IEEE, 1996
- IEEE Donald G. Fink Award, 1997
- IEEE Third Millennium Medal, 2000
- Vice-Chair of Graduate Affairs

Mau-Chung Frank Chang
Ph.D. National Chiao-Tung University, 1979

CMOS RF design, high speed analog integrated circuit design, data conversion, and other techniques of analog signal processing.

- Fellow, IEEE, 1996
- Vice-Chair of Industry Relations

Lei He
Ph.D. UC Los Angeles, 1999

Computer-aided design of VLSI circuits and systems, interconnect modeling and design, power-efficient computer architectures and systems, and numerical and combinatorial optimization.

Babak Daneshrad
Ph.D. UC Los Angeles, 1993

Digital VLSI circuits: wireless communication systems, high-performance communications integrated circuits for wireless applications.

William J. Kaiser
Ph.D. Wayne State University, 1984

Development of distributed networked, embedded computing for linking the Internet to the physical world: applications include distributed systems for factory automation, biomedical research, health care, space science, security, and defense.

- Fellow, American Vacuum Society (American Institute of Physics), 1990

Deborah C. Estrin*
Ph.D. MIT, 1985

Wireless sensor networks, environmental monitoring, participatory mobile sensing.

- Fellow, IEEE, 2004
- Fellow, AAAS, 2001
- Fellow, ACM, 2000

Dejan Markovic
Ph.D. UC Berkeley, 2006

Power/area-efficient digital integrated circuits, VLSI architectures for wireless communications, optimization methods and supporting CAD flows.

*pending approval

Sudhakar Pamarti
Ph.D. UC San Diego, 2003

Mixed-signal IC design, signal processing and communication theory, especially the design of highly integrated wireless and wireline communication systems with particular emphasis on lowering cost and power consumption; design, silicon IC implementation, and verification of mixed-signal blocks.

Mani B. Srivastava
Ph.D. UC Berkeley, 1992

Mobile and multimedia networked computing systems, design and synthesis of DSP systems, and low-power systems.
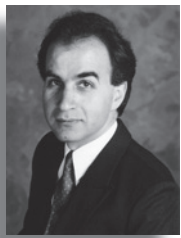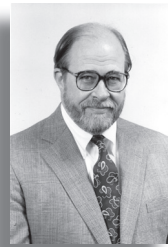
Behzad Razavi
Ph.D. Stanford University, 1992

Analog, RF, and mixed-signal integrated circuit design, dual-standard RF transceivers, phase-locked systems and frequency synthesizers, A/D and D/A converters, high-speed data communication circuits.

• Fellow, IEEE, 2003

Alan N. Willson, Jr
Ph.D. Syracuse University, 1967

Theory and application of digital signal processing including VLSI implementations, digital filter design, nonlinear circuit theory.

• Fellow, IEEE, 1996

Vwani P. Roychowdhury
Ph.D. Stanford University, 1989

Models of computation: parallel systems, quantum information processing, nanoscale and molecular electronics, statistical algorithms for large-scale information processing, combinatorics and complexity and information theory, bioinformatics, cryptography.

Chi-Kong Ken Yang
Ph.D. Stanford University, 1998

High-speed data and clock recovery circuits for large digital systems, low-power, high-performance functional blocks and clock distribution for high-speed digital processing, and low-power high-precision capacitive sensing interface for MEMS.

Henry Samueli
Ph.D. UC Los Angeles, 1980

Digital signal processing, communications systems engineering, and CMOS integrated circuit design for applications in high-speed data transmission systems.

• Fellow, IEEE, 2000
• Fellow, American Academy of Arts and Sciences, 2004
• Member, National Academy of Engineering, 2003

Janns Steps and Royce Hall

Eli Yablonovitch, *Area Director*
Ph.D. Harvard University, 1972

Optoelectronics, high speed optical communications, nanocavity lasers, photonic crystals at optical and microwave frequencies, quantum computing and communication

- Member, National Academy of Engineering, 2003
- Member, National Academy of Sciences, 2003
- Fellow, IEEE, 1992
- Fellow, American Physical Society, 1990
- Fellow, Optical Society of America, 1982
- Northrop Grumman Optoelectronics Chair in Electrical Engineering, 2005

Chi-On Chui
Ph.D. Stanford University, 2004

Heterostructure semiconductor devices and technology involving the application of novel device concepts and fabrication techniques to explore the quantum and strain effects at the nanoscale.

Bahram Jalali
Ph.D. Columbia University, 1989

RF photonics, fiber optic integrated circuits, and Datacom systems.

- Fellow, IEEE, 2003
- Fellow, Optical Society of America, 2004

Harold R. Fetterman
Ph.D. Cornell University, 1968

Optical millimeter wave interactions, femto-second evaluation of high-frequency devices and circuits, solid state millimeter wave structures and systems, biomedical applications of lasers.

- Fellow, IEEE, 1990
- Fellow, Optical Society of America, 1980

Chandrashekar Joshi
Ph.D. Hull University, England, 1979

Laser fusion, laser acceleration of particles, nonlinear optics, high-power lasers, plasma physics.

- Fellow, IEEE, 1993
- Fellow, Institute of Physics (U.K.), 1998
- Fellow, American Physical Society, 1990

Warren S. Grundfest
M.D. Columbia University, 1980

Lasers for minimally invasive surgery, magnetic resonance-guided interventional procedures, laser lithotripsy, micro-endoscopy, spectroscopy, photodynamic therapy, optical technology, biologic feedback control mechanisms.

- Fellow, SPIE, 1996
- Fellow, American Institute of Medical & Biologic Engineers, 1996

Jack W. Judy
Ph.D. UC Berkeley, 1996

MEMS, microsensors, micro-actuators, microsystems and micromachining; magnetism and magnetic materials; neuro-engineering and neuro-silicon interfaces; distributed sensors, actuators, and information.

Tatsuo Itoh
Ph.D. UI Urbana-Champaign, 1969

Microwave and millimeter wave electronics, guided wave structures, low power wireless electronics, integrated passive components and antennas.

- Fellow, IEEE, 1982
- Member, National Academy of Engineering, 2003

Jia-Ming Liu
Ph.D. Harvard University, 1982

Ultrafast optics and electronics, opto-electronics and semiconductor lasers, nonlinear optics, and optical-wave propagation.

- Fellow, American Physical Society, 2003
- Fellow, Optical Society of America, 1990

FACULTY: Physical and Wave Electronics Area

Warren B. Mori
Ph.D. UC Los Angeles, 1987

Laser plasma interactions, advanced accelerator concepts, advanced light sources.

• Fellow, American Physical Society, 1995

Christoph Niemann
Ph.D. University of Technology, Darmsstadt, Germany, 2002

Laser-plasma interactions, high-energy density physics, and inertial confinement fusion

Dee-Son Pan
Ph.D. California Institute of Technology, 1977

New semiconductor devices for millimeter- and submillimeter-wave generation and amplification, transport in small geometry semiconductor devices, generic device modeling

C. Kumar Patel
Ph.D. Stanford University, 1961

Condensed matter physics, especially the structure and dynamics of "interesting systems", broadly defined; spectroscopic techniques and detection methods; development of new laser systems

• National Medal of Science, 1996
• Member, National Academy of Engineering, 1978
• Fellow, IEEE, 1975
• National Academy of Sciences, 1974

Yahya Rahmat-Samii
Ph.D. UI Urbana-Champaign, 1975

Satellite, personal communications, microstrip, fractal, remote sensing, and radio astronomy antennas; electromagnetic bandgap structures; computational and optimization techniques, measurement and diagnostic techniques.

• Fellow, IEEE, 1985

Oscar M. Stafsudd
Ph.D. UC Los Angeles, 1967

Quantum electronics, especially IR lasers and nonlinear optics; solid-state IR detectors.

Chand R. Viswanathan
Ph.D. UC Los Angeles, 1964

VLSI devices and technology, thin oxides; reliability and failure physics of MOS devices; process-induced damage, low frequency noise; low temperature device behavior, thin oxide characterization, and device modeling.

• Life Fellow, IEEE, 1995

Kang L. Wang
Ph.D. Massachusetts Institute of Technology, 1970

Nanoelectronics and optoelectronics, MBE and superlattices, microwave and millimeter electronics/optoelectronics, quantum computing.

• Fellow, IEEE, 1992

Yuanxun (Ethan) Wang
Ph.D. University of Texas, Austin, 1999

High performance antenna array and microwave amplifier systems for wireless communication and radar; numerical modeling techniques; fusion of signal processing and circuit techniques in microwave system design.

Benjamin Williams
Ph.D. Massachusetts Institute of Technology, 2003

Quantum cascade lasers in the terahertz frequency range, and the development of terahertz components based of subwavelength dimension for use in beam control, sensing, and imaging. Development of intersubband and intersublevel based devices in low-dimensional nanostructures for electronic and optoelectronic applications.
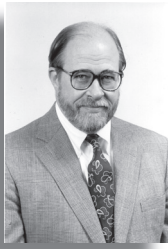
Jason C.S. Woo
Ph.D. Stanford University, 1987

Solid state technology, CMOS and bipolar device/circuit optimization, novel device design, modeling of integrated circuits, VLSI fabrication.

• Fellow, IEEE, 2005

Alan N. Willson, Jr., *Area Director*
Ph.D. Syracuse University, 1967

Theory and application of digital signal processing including VLSI implementations, digital filter design, nonlinear circuit theory.

- IEEE W.R.G. Baker Prize, 1985 and 1994
- Fellow, IEEE, 1996
- Golden Jubilee Medal of the IEEE Circuits and Systems Society, 1999
- IEEE Circuits and Systems Society Technical Achievement Award, 2000
- IEEE Third Millennium Medal, 2000
- Mac Van Valkenburg Award of the IEEE Circuits and Systems Society, 2003

Abeer A. Alwan
Ph.D. Massachusetts Institute of Technology, 1992

Speech processing, acoustic properties of speech sounds with applications to speech synthesis, recognition by machine and coding, hearing aid design, digital signal processing.

- Fellow, Acoustical Society of America (American Institute of Physics), 2003

A.V. Balakrishnan
Ph.D. University of Southern California, 1954

Laser beam distortion in atmospheric turbulence, control design for smart structures, and flight systems applications of adaptive control, nonlinear aeroelasticity, and wind power.

- Life Fellow, IEEE, 1996

Paganiotis D. Christofides*
Ph.D. University of Minnesota, 1996

Process control, dynamics and optimization, computational modeling and simulation of complex systems, and mathematics with the central objective of development of novel methods for the systematic and riigorous solution of complex process control and systems.

Michael P. Fitz
Ph.D. University of Southern California, 1989

Statistical communication theory, especially physical layer communications theory for mobile wireless communications, with emphasis on coding demodulation, synchronization, and equalization techniques.

Stephen E. Jacobsen
Ph.D. UC Berkeley, 1968

Operations research, mathematical programming, non-convex programming, applications of mathematical programming to engineering and economic systems.

Rajeev Jain
Ph.D. Katholieke Universiteit, Leuven, Belgium, 1985

Embedded hardware/software design for signal processing systems-on-a-chip; CAD tools for design of high-performance signal processing architectures and development of ASICs for spread-spectrum modems and image compression.

- Fellow, IEEE, 1999

Alan J. Laub
Ph.D. University of Minnesota, 1974

Numerical linear algebra, numerical analysis, high-end scientific computation, and computer-aided control system design, especially algorithms for control and filtering.
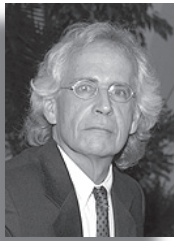
- Fellow, IEEE, 1986

Nhan Levan
Ph.D. Monash University, Australia, 1966

Control systems, especially stability and stabilizability and errors in dynamic systems; signal analysis; theory and application of wavelets.

*pending approval

Stanley J. Osher*
Ph.D. Courant Institute, New York University, 1966

Innovative numerical methods for applications ranging from image science to control to electromagnetics to computational physics and beyond.

- Member, National Academy of Sciences, 2005

Jeff Shamma*
Ph.D. Massachusetts Institute of Technology, 1988
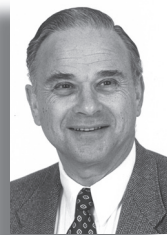
Feedback control and systems theory.

- Fellow, IEEE, 2006

Fernando Paginini
Ph.D. California Institute of Technology, 1996

Robust and optimal control, distributed control of sensors and actuator arrays, distributed networks, power systems.

Jason Speyer*
Ph.D. Harvard University, 1968

Stochastic and deterministic optimal control and estimation with application to aerospace systems; guidance, flight control, and flight mechanics.

- Member, National Academy of Engineering, 2005
- 2000 IEEE Third Millennium Medal
- Life Fellow, IEEE
- Fellow, AIAA, 1985

Gregory J. Pottie
Ph.D. McMaster University, Ontario, 1988

Communication systems and theory, with applications to personal communications, channel coding, and wireless sensor networks

- Fellow, IEEE, 2005

Mani B. Srivastava
Ph.D. UC Berkeley, 1992

Mobile and multimedia networked computing systems, design and synthesis of DSP systems, and low-power systems.

Izhak Rubin
Ph.D. Princeton University, 1970

Telecommunications and computer communications systems/networks; mobile wireless, optical, multimedia IP, ATM, satellite, and CATV networks; queueing systems, C3 systems/networks, network simulations and analysis, traffic modeling/engineering.

- Fellow, IEEE, 1987

Paulo Tabuada
Ph.D. Technical University of Lisbon, Portugal, 2002

Design of networked embedded control systems. Modeling, analysis and design of discrete-event, timed and hybrid systems. Hierarchical and distributed control design, geometric and algebraic control theory for nonlinear and Hamiltonian control systems, categorical systems theory.

Ali H. Sayed
Ph.D. Stanford University, 1992

Adaptive and statistical signal processing, distributed processing, filtering and estimation, signal processing for communications, wireless networks, algorithms for large-scale structured computations.

- Fellow, IEEE, 2001
- Department Chairman

John D. Villasenor
Ph.D Stanford University, 1989

Communications, signal and image processing, joint source and channel coding, lattice vector quantization, wavelet filter design, wireless multimedia communications, and low complexity image and video coding architectures and algorithms.

*pending approval

Lieven Vandenberghe
Ph.D. Katholieke Universiteit, Leuven, Belgium, 1992

Optimization in engineering, applications in systems and control, circuit design, and signal processing.

Mihaela van der Schaar
Ph.D. University of Technology, Eindhoven, Netherlands, 2001

Theory and design of novel algorithms, standards and systems for multimedia coding, processing and ubiquitous communication over Internet and wireless networks.

Paul K.C. Wang
Ph.D. UC Berkeley, 1960

Control systems, nonlinear distributed-parameter system theory with applications to micro-optoelectromechanical systems, micro-robots and microspacecraft.

Richard D. Wesel
Ph.D. Stanford University, 1996

Communication theory with a particular interest in coded modulation including trellis codes and turbo codes for applications including mobile wireless communication systems, multiple antenna systems, and satellite communication systems.

• Vice-Chair of Undergraduate Affairs

Kung Yao
Ph.D. Princeton University, 1965

Communication theory, signal, acoustic, and array processing, wireless communication systems, sensor networks, chaos system theory, and VLSI and systolic algorithms and architectures

• Fellow, IEEE, 1994

Student	M.S. Thesis Title	Advisor
Tang, W.	Design of an Amplitude Control Feedback Loop for Outphasing Power Amplifiers and Implementation and Measurements of Quadrature Oscillators	Abidi, A.
Picar, T.	Local Thermal Management of RF Power Amplifier for Space-Based Inflatable Phased Array Antennas	Brown, E.
Luu, L.	Relaxing RF Component Requirements in a Weaver Architecture by Learning and Adapting to the Environment	Daneshrad, B.
Chang, E.	A High Speed Tunable Optical Filter Using the Vernier Effect with Electro-Optic Polymer Sampled Bragg Gratings and Fiber Fabry-Perot	Fetterman, H. R.
Dunayevskiy, I.	Terahertz Frequency Study of Common Clothing Materials	Fetterman, H.R.
Wong, H.-Y.P.	FGPA Device and Architecture Evaluation Considering Process Variation	He, L.
Chopra, N.	An Enhanced Microwave Large-Signal Device Model	Itoh, T.
Ash, E.	Continuous Phase Shifter using Ferroelectric Varactors and Composite Right-Left Handed Transmission Lines	Itoh, T.
Leung, M.	Design and Implementation of a Memory-Based 128- Point Ifft/64- Point FFT for use in Wireless LAN 802.11a/G Applications	Jalali, B.
Zhou, M.	Development and Applications of the Ionization Package in Quickpic – A Novel Quasi-Static PIC Code for PWFA Study	Joshi, C.
Ralph, J.	Design and Evaluation of a High Power Terahertz Source Based on Nonlinear Frequency Mixing in GAAS	Joshi, C.
Chiang, F.	Voltage and Electric-Field Probes for Laboratory Plasmas	Judy, J.
Pon, R.	Networked Infomechanical Systems: A Mobile Embedded Networked Sensor Platform	Kaiser, W.
Liu, D.	General Embedded Bayes Engine	Kaiser, W.
Lucas, C.	Localization of Fixed and Mobile Sensor Nodes	Kaiser, W.
Lander, D.	Square Root using Limited Precision Primitive Operations	Kaiser, W.
Zhang, Q.	A Metamorphic Compiler	Mangione-Smith, W.H.
Omoto, D.	Computing Inference in Bayesian Networks Using a Reconfigurable System	Mangione-Smith, W.H.
Grot, B.	Precise Flow Tracking in High-Speed Networks: Memory Performance Analysis and Techniques for Performance Enhancement	Mangione-Smith, W.H.
Carwana, J.	Acquiring and Distributing Medium Models for Sensing Performance Estimation	Srivastava, M.
Lee, D.	Ragobot: A Mobile Sensor Platform for Controlled Exploration	Srivastava, M.
Hsu, J.	Environmental Energy Harvesting Support for Wireless Sensor Networks	Srivastava, M.
Lee, K.	Cyclops: Dynamic Reconfiguration in Image Sensing Wireless Network	Srivastava, M.
Tsigkogiannis, I.	Time Synchronization Middleware for Low-Power Wireless Ad-Hoc Networks	Srivastava, M.
Lin, C.	Spectroscopic and Lasing Properties of Codoped EU, ER:YAG Mid-IR Laser	Stafsudd, O.M.
Argawal, G.	Capacity Planning of Commodity Products under Competition	Vandenberghe, L.
Tran, D.	Charge Recycling Differential Cascade Voltage Switch Logic: A Low Power IC Solution Against Differential Power Analysis	Verbauwhede, I.
Tily, M.	Power Models for Differential Power Analysis at Different Levels of Abstraction	Verbauwhede, I.

Student	M.S. Thesis Title	Advisor
Chen, C.	*GE Quantum Dot Infrared Photodetectors*	Wang, K.L.
Chen, J.	*A Preliminary Research of the Manganese Germanium Based Spintronic Device*	Wang, K.L.
Ogawa, M.	*Dosage Dependence of GE Quantum Dots Grown on Carbon-Implanted SI Substrates*	Wang, K.L.
Jing, H.	*Switched Resonant Antennas for UWB Pulse Transmission*	Wang, Y.
Baek, S.	*A 0.18-UM M CMOS 2.5-GB/S Data Serializer*	Willson, Jr., A.N.
Gupta, G.	*Laterally Asymmetric Channel Engineering in Deep Sub-micron CMOS Devices for Analog and Mixed Mode Applications*	Woo, J.
Lee, J.	*Evaluation of Fully-Integrated Switching Regulators for CMOS Process Technologies*	Yang, C.K.K.
Modjtahedi, S.	*A 500 MHz Analog Fir Filter Based on an HTS Delay Line*	Yang, C.K.K.

Comprehensive Exam Option

Student	Advisor		Student	Advisor
Borgstrom, B.	Alwan, A.		Idrissi, G.	Rubin, I.
Tang, J.	Alwan, A.		Lin, S.-Y.	Rubin, I.
Hsiung, J.	Balakrishnan, A.V.		Liu, Y.	Rubin, I.
Bordbar, R.	Daneshrad, B.		Sadek, M.	Sayed, A.H.
Kim, H.S.	Daneshrad, B.		Zahedi, S.	Srivastava, M.
Wu, W.	Daneshrad, B.		Park, H.	van der Schaar, M.
Kim, K.	Fitz, M.		Lee, J.	Vandenberghe, L.
Lee, S.	Fitz, M.		Merello, B.	Willson Jr., A.N.
Truong, A.	Fitz, M.		Woo, B.	Willson, Jr., A.N.
Kakttakayam, J.	Jain, R.		Soo-Hoo, S.	Wu, M.
Chang, A.	Judy, J.		Chew, E.	Yao, K.
Jew, R.	Kaiser, W.		Hedayati, K.	Yao, K.
Shirachi, L.	Kaiser, W.		Hernandez, J.	Yao, K.
Xing, D.	Kaiser, W.		Hwang, J.	Yao, K.
Javelo, A.	Mangione-Smith, W.H.		Kasantikul, W.	Yao, K.
Thamvechvitee, P.	Paganini, F.		Lee, J.	Yao, K.
Jin, T.	Pottie, G.		Mak, K.	Yao, K.
Ni, K.	Pottie, G.		Ozguc, M.	Yao, K.
Pour, S.	Pottie, G.		Vemuru, B.	Yao, K.
Yang, S.	Pottie, G.			
Bezenek, S.	Rahmat-Samii, Y.		**Engineer Degrees**	
Kong, J.	Roychowdhury, V.		Y. Taima	Sayed, A.H.
Singh, S.	Roychowdhury, V.		J. Afrasiabi	Fetterman, H.

Student	Dissertation Title	Advisor
Cui, X.	Environmental and Speaker Robustness in Automatic Speech Recognition with Limited Learning Data	Alwan, A.
Mok, T.K.	Stochastic Estimation and Control of Wind Turbines for Enhancement of Efficiency	Balakrishnan, A.V.
Ko, J.-W.	Multi-Band Transceivr Architectures and Circuits for Chip-to-Chip Communication	Chang, M.C.F.
Mehrnia, A.	System and Hardware Analysis and Design for Scalable Radio Structure	Daneshrad, B.
Geary, K.	Polymer Electro-Optic Waveguide Devices: Low-Loss Etchless Fabrication Techniques and Passive-To-Active Integration	Fetterman, H.
Chen, J.	Modeling and Optimization of Interconnects and Package for Signal and Power Integrity	He, L.
Liao, W.	Power-Thermal Modeling and Management of Integrated Circuits and Systems	He, L.
Long, C.	Circuit and Physical Design for System-Level Power and Performance	He, L.
Xiong, J.	Modeling and Design Optimization Considering Nanometer Process Variation Effects	He, L.
Lim, S.	Advanced Microwave/Millimeterwave System Technologies for Wireless Communications	Itoh, T.
Lan, C.-C.	Fixed-Point Design Methodology of Digital Transceivers	Jain, R.
Johnson, D.	Positron Production by X-Rays Emitted from Betatron Motion in a Plasma Wiggler	Joshi, C.
Yee, J.	Shock Resistant Low-Power Ferromagnetic MEMS Magnetometers	Judy, J.
Majumdar, S.	New Approaches to Operator-Theoretic Frameworks for Wavelet Multiresolution Approximation and Analysis	Levan, N.
Saisan, P.	Modeling and Analysis of Dynamic Visual Phenomena: A System Theoretic Approach	Levan, N.
Newman, A.	Establishment and Validation of Wavelength and Noise-Related Characteristics of Bandgap-Engineering, Photovoltaic Optical Detectors	Liu, J.M.
Huang, C.	Quasi-Static Modeling of Beam-Plasma and Laser-Plasma Interactions	Mori, W.
Lee, C.-I.	Investigation of P-N Junction Inductors for RF CMOS Circuits	Pan, D.S.
Shen, K.-Y.	A Metal-Oxide-Semiconductor Tunneling Effect Transistor	Pan, D.S.
Kon, K.	Dual-Frequency Dual-Polarized Stacked Patch Microstrip Arrays: An Invstigation of Their Suitability for Soil-Mositure Remote-Sensing Applications	Rahmat-Samii, Y.
Bridgewater, J.	Balanced Overlay Networks (BON): Decentralized Load Balancing and Analysis of Large-Scale Systems	Roychowdhury, V.
Lu, Y.	Kernel Optimization and Distribution Learning Algorithms for Support Vector Machines	Roychowdhury, V.
Luo, H.	Energy Efficient Sampling, Source Coding and Data Routing in Wireless Sensor Networks	Rubin, I.
Tarighat, A.	Multiple-Input Multiple-Output (MIMO) OFDM Systems with Implementation Impairments	Sayed, A.H.
Ganeriwal, S.	Trustworthy Sensor Networks	Srivastava, M.
Somasundara, A.	Controlled Mobility for Efficient Data Collection in a Wireless Sensor Network	Srivastava, M.
Tsiatsis, V.	Field-Level Energy Management in Sensor Networks	Srivastava, M.
Sorbel, S.	Echo Frequency Reduction in Pyroelectrics	Stafsudd, O.M.
Hodjat, A.	HW/SW Co-Design and ASIP Architectures for Cryptographic Primitives in Embedded Security Systems	Verbauwhede, I.
Baron, F.	Electron G Factor Engineering in Silicon Germanium Bulk Alloys and Strained SI1-XGEX/ST1-YGEY Heterostructures	Wang, K.L.
Yao, W.	Digital Controlled Antenna and Antenna Array in Wireless Communication	Wang, Y.E.
Shi, J.	Universal Channel Codes and Trellis State-Diagram Reduction	Wesel, R.
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Prof. F. Chang

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