2018 ASEE Annual Conference & Exposition
June 24–27, 2018 Salt Palace Convention Center Salt Lake City, UT
Paper ID #22584

Different Strategies for Preparing Students to Tackle the RF Engineering Challenges of Tomorrow: a Panel Discussion

Ms. Erica Messinger, Keysight Technologies

Erica Messinger is the Keysight Technologies Director Worldwide University Program providing strategic vision and leadership for the company's multi-tiered engagements with Universities and Academic/Research Institutions. She works collaboratively across various touch points throughout Keysight and with academic institutions to unify and optimize engagements in the "education ecosystem." This includes equipping Universities with the right solutions in the research and teaching labs, connecting research collaboration opportunities, inspiring the next generation of engineers, helping academia prepare industry-ready engineers, and mapping out potential career paths for students. Erica has been with Hewlett Packard/Agilent Technologies/Keysight Technologies for 19 years holding various roles including sales channel management, business development, applications engineering, product support, and program management, most recently in Keysight's Power and Energy business. She has brought numerous products to the marketplace meeting customer needs, and ensured sales channel readiness and alignment with customer buying processes to facilitate business growth. She currently serves on the Electrical and Computer Engineering Department Heads Association (ECEDHA) Corporate Advisory Council, as the Treasurer/Secretary for the American Society for Engineering Education (ASEE) Corporate Member Council, and as a long-time member of the Society of Women Engineers (SWE) Corporate Partnership Council. She has partnered with SWE on large programs targeting K-12 outreach to inspire youth to pursue STEM fields, on developing leadership attributes with collegiate members, and retention strategies for professional women engineers. Past board experience includes serving on the University of Illinois at Urbana Champaign (UIUC) Electrical and Computer Engineering Alumni Advisory Board 2006-2009 and the Nevei Kodesh Board of Directors 2010-2014. Erica mentors at all levels both inside and outside of her organization, is an avid supporter and advocate for the next generation, and has a deep commitment for empowering women in engineering. She has a B.S. in Electrical Engineering with an International Minor in Japanese Studies from the University of Illinois @ Urbana-Champaign and an M.B.A. from the University of Colorado and has helped recruit from both of these schools. Erica loves reading food blogs, volunteering in the community, dancing with her partner, and spending time with their two young children.

Prof. Kathleen L. Melde, University of Arizona
Prof. Jonathan Chisum, University of Notre Dame
Dr. Julio Urbina, Pennsylvania State University

JULIO V. URBINA, Ph.D is an Associate Professor in the School of Electrical Engineering and Computer Science at Penn State. His educational research interests include effective teaching techniques for enhancing engineering education, global engineering and international perspectives, thinking and working in multi-, inter-, and transdisciplinary ways, cyberlearning and cyber-environments, service and experiential learning, teaming and collaborative learning.

Prof. Jing Wang, University of South Florida
Prof. Stephen E. Ralph, Georgia Institute of Technology

Different strategies for preparing students to tackle the RF engineering challenges of tomorrow – a Panel Discussion

Abstract

The trend is clear, technology innovations will increase at even faster rates in the future. This has been particularly true in communications as RF technology becomes ubiquitous in daily life. The IoT explosion and 5G revolution are driving increased demand for RF engineers posing a challenge to how schools keep up with that demand, and best prepare the next generation of RF engineers.

This session will be a panel discussion bringing together voices from multiple universities sharing how they are each innovating their RF curriculum and helping prepare engineering students ready to tackle tomorrow's RF challenges. More specifically, we will learn about how the University of Arizona, the University of Notre Dame, Pennsylvania State University, the University of South Florida, and Georgia Institute of Technology are taking advantage of partnerships with industry to accelerate their impact.

Each of these schools have their students demonstrate RF technical knowledge, design expertise, and hands-on measurement proficiency in the use of Keysight EEsof EDA software design tools and Keysight instruments. Students can complete qualification as Keysight Technologies, Inc RF and Microwave Industry-Ready Students demonstrating immediate value to prospective employers while confirming each university's commitment to preparing students for future industry contribution. The program utilizes an industry workflow environment providing a comprehensive way to simulate, measure and analyze communications components and systems.

The panel, moderated by Keysight Technologies, will highlight what strategies each of these universities have adopted leveraging Keysight's RF and Microwave Industry-Ready Student Certification Program to develop RF industry-ready engineers. These include partnering with other third-party companies, use of particular resources, etc. Attendees will be inspired with ideas of what they too might be able to leverage to help prepare the next generation of RF engineers to start contributing to the abundant RF technology opportunities.

Speakers: moderator and panelists

Erica Messinger, Director Worldwide University Program, Keysight Technologies

Erica Messinger is the Keysight Technologies Director Worldwide University Program providing strategic vision and leadership for the company's multi-tiered engagements with Universities and Academic/Research Institutions. Ms. Messinger has been with Hewlett Packard/Agilent Technologies/Keysight Technologies for 19 years holding various roles in sales channel management, business development, applications engineering, product support, and program management. She currently serves on the Electrical and Computer Engineering Department Heads Association Corporate Advisory Council, as the Treasurer/Secretary for the American Society for Engineering Education Corporate Member Council, and as a long-time member of the Society of Women Engineers Corporate Partnership Council. She has a B.S. in Electrical Engineering from the University of Illinois at Urbana-Champaign and an M.B.A. from the University of Colorado.

Dr. Kathleen L. Melde, Professor and Director of Graduate Studies, Department of Electrical and Computer Engineering, University of Arizona

Kathleen L. Melde, received the Ph.D. degree in Electrical Engineering from UCLA. She worked in the Radar Systems Group at Hughes Electronics (now Raytheon) for 12 years developing antennas and transmit/receive (T/R) modules for airborne phased and active arrays. She is now a full professor in the Electrical and Computer Engineering Department, at the University of Arizona, Tucson. Her current projects include tunable RF front ends for cognitive radio, on chip antennas, and antennas for wildlife tracking. She has over 100 publications and 5 U.S. patents. Dr. Melde is an IEEE Fellow and was University of Arizona College of Engineering Teaching Fellow in 2012. She is currently the director of Graduate Studies in ECE at the University of Arizona. Her teaching interests are in Antenna engineering, Microwave Engineering, and Electrical Packaging.

Dr. Jonathan Chisum, Assistant Professor, Department of Electrical Engineering, University of Notre Dame

Jonathan Chisum is an Assistant Professor of Electrical Engineering at the University of Notre Dame. Prior to this he was a Member of Technical Staff at MIT Lincoln Laboratory where his research focused on millimeter-wave circuits, antennas, and phased arrays for wireless communications and electronic warfare. Dr. Chisum received a B.S. in Electrical Engineering from Seattle Pacific University, and an M.S. and Ph.D. in Electrical Engineering from the University of Colorado at Boulder. Between his B.S. and his graduate studies Dr. Chisum worked as a design engineer in aerospace electronics. This industry experience informs his teaching philosophy of mentorship and hands-on project-based learning. Dr. Chisum's research focuses on resource-efficient electronics and antennas for millimeter-wave wireless communications and wideband electromagnetic spectrum sensing.

Dr. Julio Urbina, Associate Professor, School of Electrical Engineering and Computer Science, Pennsylvania State University

Julio Urbina is an Associate Professor of Electrical Engineering in the School of Electrical Engineering and Computer Science. He received the B.S. degree in Electronics Engineering from the Universidad Nacional de Ingenieria, Lima, Peru, and the M.S. and Ph.D. degrees in Electrical Engineering from the University of Illinois at Urbana– Champaign. He was with Jicamarca Radio Observatory, Lima and then the University of Arkansas at Little Rock and the Arecibo Observatory, Puerto Rico for 8 years. In 2006, he joined Penn State, University Park. Dr. Urbina’s research areas include electromagnetics, remote sensing and space systems. He is a member of the American Geophysical Union, International Union of Radio Sciences Commissions G, Institute of Electrical and Electronics Engineers, and American Society for Engineering Education.

Dr. Jing Wang, Associate Professor, Department of Electrical Engineering, University of South Florida

Jing Wang is the Co-Director of Center for Wireless and Microwave Information Systems and an Associate Professor in the Department of Electrical Engineering at University of South Florida. He has two M.S. degrees in electrical engineering and mechanical engineering, and a Ph.D. degree from the University of Michigan. His research interests include microwave and mmW devices, RF/microwave circuits and MMICs, RF additive manufacturing, RF MEMS and micromachined transducers, functional nanomaterials and nanofabrication. Dr. Wang has acted as principal investigator or co-investigator on over 30 research projects, has been awarded 9 U.S. patents and has published over 100 refereed journal and conference papers.

Dr. Stephen E. Ralph, Professor, School of Electrical and Computer Engineering, Georgia Institute of Technology

Stephen E. Ralph is a Professor with the School of Electrical and Computer Engineering at the Georgia Institute of Technology. He received a B.S. in Electrical Engineering from Georgia Tech and a Ph.D. in Electrical Engineering from Cornell University. Before joining Georgia Tech, he was a postdoctoral fellow at AT&T Bell Laboratories, Murray Hill, NJ and a visiting scientist at the IBM T. J. Watson research center Yorktown Heights NY. Dr. Ralph is also the Director of the Georgia Electronic Design Center at Georgia Tech and is the founder and director of the Terabit Optical Networking Consortium.

Introduction – extended summary of the panel message

Look around. Our world is becoming increasingly more connected. Ten years ago, using a phone for streaming live video or conducting business operations was limited and nearly unimaginable. Looking into the future ten years from now promises new technologies and capabilities that will in turn further revolutionize everything we know now about communications. The 5G revolution is emerging and promises unprecedented advances in terms of frequency coverage, data rates, numbers of simultaneous users, spectral efficiency, and reduced latency. Beyond 5G, new wireless-enabled applications for Internet of things, smart home and building technologies, and integrated health platforms are quickly emerging as well.

5G technologies and beyond, create challenging requirements such as higher data throughput, faster data communication speeds, higher levels of semiconductor integration, less power consumption and perfect accuracy of each signal. These constraints are pushing the design boundaries on the organizations that create the electronics and the communications and networking innovations that we rely on every day. Companies are increasingly required to innovate at faster and faster rates with time-to-market pressures and the need for productivity gains. Universities have an opportunity to produce students who are industry-ready knowledgeable of the engineering design tools and processes used by industry, that allows them to start contributing faster and bring greater value to their new organizations. The demand for new engineers ready to "jump in" and tackle some of these RF technology breakthroughs is only increasing.

The Keysight RF Industry Ready Certification Program serves as a collaboration between industry and universities to produce and recognize industry-ready engineers. This allows industry to hire with confidence knowing that the productivity of the new employee is assured from day one. More than 40 universities around the globe have adopted and use this Program in their curriculum. The panel will share different strategies they have created at their universities to embed hands-on engagement activities using Keysight solutions. This represents a new concept of an industry-university partnership. One unique aspect about the Keysight RF Industry-Ready Certification Program is that students who obtain the certification can opt-in to being included in the Keysight database. This allows employers to verify a particular standard of skills obtained during the course, and provides confidence that a new employee is ready to go.

Participating doctoral student Thomas Zirkle exclaimed, “Receiving the Keysight RF/MW Industry-Ready Student Certificate is an added benefit to my time here at Notre Dame, a seal of approval that demonstrates my skill and specific hands-on experience with these technologies and cutting-edge equipment. It is a true mark of distinction that will help open doors of opportunity.”

Colorado School of Mines Assistant Professor of Electrical Engineering Payam Nayeri, who is also director of the Microwave and RF Laboratory was quoted, “Students awarded the certification demonstrate their achievements in the knowledge and usage of Keysight EEsof EDA [Electronic Design Automation] software and instrumentation. These students will immediately be able to deliver faster results at a higher level to our industry partners and, ultimately, their employers.”

What follows are some details outlining how five different universities integrate industry standard tools in to their curricula and utilize this Program to ensure their students are industry-ready. Their students are able to begin contributing immediately having had experience using industry standard tools to advance RF technology as it becomes more and more ubiquitous. They are prepared to work in and with RF technology, which has been referred to as the magic behind our increasingly connected world. We will be discussing each of these implementations and key learnings during the panel discussion.

Individual university activities / program implementation

University of Arizona - Dr. Kathleen L. Melde, Professor and Director of Graduate Studies, Department of Electrical and Computer Engineering, University of Arizona

The RF Engineering program in the Electrical and Computer Engineering Department at the University of Arizona offers a full range of courses. Undergraduate students take beginning Electromagnetics. Seniors and graduate students can choose courses such as Microwave Engineering I (passive RF circuits), Microwave Engineering II (active circuits), Antennas, Advanced EM Theory, and Electrical Packaging Principles. There are several degree options, BSEE, an accelerated MSEE (BS +1 year), on campus MSEE, on-line MSEE, and the Ph.D.

The University of Arizona (UA) is consistently rated high in the area of student engagement. The UA’s mission is to have 100% student engagement, which involves experiences beyond regular classroom instruction to help prepare students for industry. The Keysight Industry-Ready Program is one such activity the RF engineering program uses to foster student engagement. We believe that exposing students to typical EDA tools used in industry to enhance the in-class activities is an important part to learning. The student version of Keysight’s Advanced Design System (ADS) that can be downloaded for a limited time using the university email is instrumental. Students enjoy being able to use ADS on their own laptops “on demand” much more than coming in to a University computer lab to complete their work. The 24/7 access of ADS during the 15-week course fosters creative exploration of microwave concepts.

Activities using ADS are blended with analytical assignments in the Microwave I and II and the Electrical Packaging courses. Students are provided a PowerPoint tutorial created by a graduate student on a typical microwave device (Linecalc and a Wilkinson Power Divider). The tutorial is created “for students/by students”, and new students appreciate being taught by a peer. In the courses, students are required to use ADS to finish a practical design of a microwave device for a course project. The main purpose is to show students how to verify their paper designs through simulation and to introduce students to practical matters they may see in industry. This includes exploring the impact of microstrip bend and tee artifacts in order to make a practical device conform to specific ports on a fixture. Students can adjust their designs to re tune their devices when these practical matters are added. Students also use ADS to explore concepts such as variability in device dimensions or reverse engineering an existing layout given mask dimensions and measured S parameters. The ADS projects are easily implemented in both the main campus and in on-line courses.

Industry-ready microwave students are introduced to RF measurements as well. Current course enrollment in Microwave I is 40. Fourteen students are taking the course on-line. The University of Arizona does not offer a TA for graduate courses. So, in order to introduce measurements to the students, a 30-minute-long video (created by a graduate student) is provided via You Tube. The graduate student has 10 years of industrial work experience and demonstrates via the “virtual lab tour” two port calibrations using the Keysight FieldFox network analyzer. The video focuses on good lab practices such as proper techniques for using the torque wrench and ways to check the calibration when finished. The virtual lab tour provides a much-needed tutorial on a current VNA. Student learning is assessed by answering a 15-question quiz on what they learned.

In summary, ADS is a resource that can be used as a partner with well-known Microwave I texts. It can solidify student learning and foster an environment for further exploration of devices and systems (by trial and error.) We specifically avoid the use of optimization as the goal is to build intuition for checking accuracy, practical issues in design, and larger pre-manufacturing studies. Course reviews consistently request more and more training for RF industry-readiness.

University of Notre Dame - Dr. Jonathan Chisum, Assistant Professor, Department of Electrical Engineering, University of Notre Dame

The University of Notre Dame was established in 1842 and the College of Engineering was established in 1873. Instruction in electrical engineering (“EE”) at Notre Dame began with “Practical and Experimental” courses in electricity added to the civil engineering curriculum in 1891. A separate undergraduate program in electrical engineering was established in 1895, and graduate studies followed several decades later. A Master of Science in Electrical Engineering (MSEE) program was instituted in 1946 and the Ph.D. program in electrical engineering was established at Notre Dame in 1963.

Prior to 2015, the Department of Electrical Engineering emphasized two broad sub-disciplines: electronic materials and devices (“EMD”) and electronic circuits and systems (“ECS”) with RF and microwave engineering falling under the EMD umbrella and being supported by an undergraduate and graduate course in Electromagnetics, and a first course in Microwave Circuit

Design and Measurement. In 2015 Notre Dame launched the circuits initiative and was able to extend the offerings in RF and microwave engineering. Three new faculty with expertise in high-frequency devices, optical and wireless biomedical applications, and microwave circuits and systems joined the team and two new graduate courses: Microwave Power Amplifier Design and Fabrication, Active Microwave Circuits for Wireless Communications, and Antenna Theory were created. Additionally, some special topics courses have been offered in Microwave Calibration and Microwave-Photonics.

Within these, a two-course sequence of Microwave Circuit Design and Measurement and Active Circuits for Wireless Communications comprise the core RF and microwave circuits curriculum:

- Microwave Circuit Design and Measurement. This is a cross-listed senior/graduate level course based on David Pozar's *Microwave Engineering* text. It provides an introduction to transmission line theory, network analysis, matching, as well as small-signal amplifier design. Design projects use the Keysight ADS software. Circuits are milled by TAs and soldered and measured by students. The course emphasizes microwave measurement including calibration and measurement using network analyzers, spectrum analyzers, signal generators and power meters.
- Active Microwave Circuits for Wireless Communications. This is a second-year graduate course that deconstructs radio design from a systems perspective and then covers detailed circuit design of various radio components. In support of this course, the university designed a Super-heterodyne radio lab kit in conjunction with X-Microwave and Keysight to introduce microwave wireless systems analysis as a motivation for circuit design. This module includes cascade analysis and transceiver design. Students create their own cascade analysis tools and then compare their results with a Keysight SystemVue model. They confirm predictions with laboratory measurements of the X-Microwave lab kits including linear (network analyzer) and nonlinear (two-tone tests) measurements. The X-Microwave modules allow students to track performance metrics through a cascade of a realistic circuit without perturbing the circuit so they can verify their system analysis. Then the course takes a deep dive into circuit design where students use Keysight ADS to design, fabricate, and measure a 10 watt, 2.45 GHz power amplifier and a balanced mixer. The power amplifier uses a popular 10 watt GaN HEMT transistor and high-fidelity nonlinear models are used to facilitate software-based load-pull design methods. The design and measurement lab emphasizes stability analysis, fabrication methods including PCB and heatsink fabrication, and testbed design including highly linear two-tone test setups. In addition, the amplifier S-parameters are measured with a 4-port VNA using SOLT calibration standards. The balanced mixer lab uses Schottky diode nonlinear models and full-wave electromagnetic simulation of the layout in ADS Momentum. Measurement includes a 4-port VNA for S-parameter measurements and the design of a testbed based upon signal generators and signal analyzers to determine conversion loss, IIP3, and desensitization. In the end, a semester final project allows the students to explore topics relevant to their research and can include system analysis (in MATLAB, SystemVue, etc.), algorithms for mitigating hardware impairments (e.g., IQ equalization, digital predistortion), or a circuit design of some component we did not cover in the course (e.g., LNA, oscillator).

Both courses emphasize design, fabrication, and measurement which forces students to go beyond theory and understand the nuance of practical RF and microwave design. Top students from the first course are nominated for the Keysight Industry Ready Level 1 certificate and top students from the second course are nominated for a Keysight Industry Ready Level 2 certificate.

Pennsylvania State University - Dr. Julio Urbina, Associate Professor, School of Electrical Engineering and Computer Science, Pennsylvania State University

The RF and Microwave Engineering Course at Penn State is organized in two 75-minute lecture sessions and one 120-minute laboratory session per week. In the laboratory, the students are organized into groups of two to three students per bench across six working benches in the lab. This course provides an introduction to the world of RF and Microwave design, analysis, and engineering. With the proliferation of wireless devices, it is vital for today's engineers to have a working knowledge of RF and Microwave design and measurement techniques that were once considered a "black art". Today, engineers have available a wide variety of CAD software to model and predict the behavior of RF devices and systems and sophisticated measurement instruments to verify performance. The use of software together with a thorough understanding of the underlying fundamentals will go a long way towards achieving first-pass success with designs. The ADS package from Keysight Technologies as an integral part of the course.

The course begins with a historical overview of RF and Microwave systems followed by a transmission-line view of RF circuit concepts including standing waves, impedance matching, the Smith Chart, S-Parameters, and microwave network analysis. Once the transmission-line viewpoint is developed, it is applied in the study of typical RF and microwave components including attenuators, terminations, transformers, hybrids, baluns, power dividers and combiners, and impedance-matching networks. The course concludes with the design of microwave transistor amplifiers and covers the topics of DC biasing, impedance matching, noise matching, gain, noise figure, dynamic range, and stability analysis.

For the students to become industry-ready RF and microwave engineers and therefore comply with Keysight RF Industry Ready Certification Program, they get exposure to the practical aspects of the topics discussed in the lectures through lab experiments and projects, giving them hands-on exposure to RF and microwave circuit fabrication, tuning, and performance verification using microwave network analyzers, signal sources, spectrum analyzers, and noise figure meters. During the first part of the semester the laboratory work requires learning about ADS (microwave CAD software) from Keysight Technologies, the RF and Microwave test equipment (vector network analyzer, spectrum analyzer, etc.), fundamentals of RF and microwave measurement techniques, and standard lab practices. Gaining familiarity with these "tools of the trade" is the desired outcome for the series of lab exercises.

During the remainder of the semester each team works on a project that involves the design, construction, and testing of a discrete transistor microwave amplifier at 1.3 GHz. At the conclusion, each team then makes an oral presentation and submits a formal written report.

University of South Florida - Dr. Jing Wang, Associate Professor, Department of Electrical Engineering, University of South Florida

The University of South Florida (USF) was the first school to implement and begin using the Keysight RF Industry Ready Certification Program. It is integrated in to one of the signature undergraduate/graduate level courses, the Wireless and Microwave Information Systems (WAMI) Lab. The class is an extensive hands-on introduction to wireless radio frequency and microwave circuits and systems, involving modern measurements, fabrication and computer-aided design experiences at both component and sub -system levels. Students learn how to design and characterize all the key major building block components of a super-heterodyne receiver until they can build and test one in their final labs (one in ADS CAD and another is based upon coaxial components). This course, also known as Wireless Circuits & Systems Design Laboratory, follows a "flipped-classroom" whereby students access recorded lectures prior to coming to the Friday class and discussion. This is also the gate course for the Wireless Circuits and Systems Track in the BSEE program, and is followed by technical electives on microwave circuits, MMIC design and microwave measurements.

As noted by Thomas Weller, electrical engineering professor and department chair who also serves as director of USF's Center for Wireless and Microwave Information Systems (WAMI) for which the course was named, "Schematics help us to predict performance of high frequency electronics and to develop working prototypes. This software [Keysight EDA] allows us to work out the kinks on the computer without having to make prototypes at every stage of improvement or change, saving time, resources and money." Students will fine-tune their schematics for three-dimensional models of antennas and similar devices using the Keysight Automated Design Software (ADS). "There are two types of research – experiential and theoretical," said Weller. "This EDA software helps with both. Our students will graduate from USF ready to work in the real world on existing products and ready to help create new ones. We're excited about helping to provide the workforce our country needs."

Four of the WAMI faculty members teach this class in rotation at a frequency of once per year (Jing Wang, Gokhan Mumcu, Tom Weller, and Larry Dunleavy), with help from typically 5-6 WAMI lab TAs. Each weekly lab session is 3.5 hours and there are 7 test benches filled with Keysight equipment (i.e., vector network analyzer, signal analyzer, oscilloscope, etc.) which was recently upgraded to include PXI VNAs (9GHz) and SAs (26.5GHz) with built-in phase noise, noise figure testing features and more.

For students who have completed the WAMI lab and get an A score, they will be offered a chance to take a 1-hour hands-on exam to test and characterize an unknown component (device with coaxial ports given to them randomly). And those who can design experiments to fully characterize the device while properly reporting the key specifications, would then be nominated/offered the Keysight Industry Ready Level 1 certificate.

Georgia Institute of Technology - Dr. Stephen E. Ralph, Professor, School of Electrical and Computer Engineering, Georgia Institute of Technology

Georgia Tech has been using the Keysight EEsof design tools for well more than a decade. The School of Electrical and Computer Engineering has ~1400 undergraduates and 1100 graduate students and the RF engineering and RF laboratory course offerings experience high demand. These courses, and others, have integrated the Keysight Advanced Design System (ADS) and SystemVue solutions tools into the curriculum. ADS is essential design automation software for RF, microwave and high-speed digital applications and has effectively become an industry standard as most companies that hire Georgia Tech students expect they are familiar with this tool. The curriculum covers basic RF design to broadband device and system design. Both theoretical concepts and practical laboratory experience span RF/microwave measurement theory and techniques to 10's of GHz. SystemVue is also used by multiple teams within the Georgia Electronic Design Center (GEDC) which is a cross-disciplinary electronics and photonics research center with more than 15 active faculty and over 100 graduate and undergraduate students. SystemVue enables the researchers to explore architectures and algorithms for a wide variety of communications systems including wireless and optical links which include RF, Optical and DSP subsystems. Research efforts have application in both commercial and defense systems.

As the largest electrical engineering program in the country and striving to be the best, Georgia Tech places strong value on preparing students to be successful contributors to continued technology advancement. As Barrett H. Carson, Vice President of Development, Georgia Institute of Technology, once said, "If you're among the best institutions in the world, you want to be working with the best SW in the world. And why would you want to look anywhere beyond [Keysight] Technologies." Students get to use the exact same tools they are expected to use when they enter industry or lead their own research. In addition to the software adoption, students work with the Keysight FieldFox microwave analyzers in classes like Electromagnetics, Signals and Systems, and Analog Integra Circuits, and the EXG X-series RF vector signal generator in the Communication Systems Lab and Telecommunications classes. Discussions are underway for formalizing the Keysight RF Industry Ready Certification Program.

Certification program summary

Keysight EEsof EDA (Electronic Design Automation) is the leading supplier of electronic design automation software for communications product design. RF and Microwave circuit, high-speed, signal integrity, device modeling, power electronics, and signal-processing design engineers accelerate the development of better products using design flows built on our device modeling, electro-thermal, electromagnetic, circuit and system design and simulation tools. Exposing students to it allows them to develop skills that will serve them throughout their careers. A working knowledge of Keysight EDA's design tool capabilities allows students to enter the workforce as industry-ready engineers. Additionally, the software enables professors to encourage student creativity and students to capture and present that creativity in a form that's recognized and trusted in conference papers, presentation and proposals.

As exemplified by each of the featured universities, participating universities must use one or more Keysight EEsof design tools in their curriculum (Advanced Design System (ADS), Genesys, SystemVue, EMPro, IC-CAP) accompanied by Keysight instrumentation for the measurement of their RF and Microwave devices (such as network analyzers, sources, receivers, oscilloscopes, etc.). The student then becomes involved in the design, building, measurement, and analysis of RF and Microwave components to help students gain real-world understanding of RF and Microwave design and measurement techniques.

The ideal curriculum and lab will involve elements of design, building, measurement, and analysis of RF and Microwave components to help students gain real-world understanding of RF and Microwave design and measurement techniques. The certification process for students then includes passing the RF and Microwave class, completing the required hours of Keysight Electronic Design Automation Software design tools use, and completing the required use of Keysight instruments while learning key fundamentals for accurate RF calibration and measurement. The university professor will then nominate students for certification who then must pass a final hands-on test demonstrating aptitude in the subject matter.

There are two levels of certification:

- Level 1 proficiency indicates basic Keysight EDA tool knowledge and basic measurement expertise. These can be things like ADS circuit filter design and Network Analyzer S-parameter measurements of filter.
- Level 2 proficiency implies additional design analysis with Keysight EDA tools (possibly other design tool expertise such as EMPro or SystemVue) along with more involved measurement expertise.

Participation in the Keysight RF and Microwave Industry-Ready Student Certification Program confirms the student's technical knowledge, design expertise, and hands-on measurement proficiency in the use of Keysight EEsof software design tools and Keysight instruments making the student more attractive to potential employers and thereby also benefiting other industry partners. Certification ensures the student has completed an RFIC, RF Board, Microwave, or System design class. Students will have basic knowledge of DC simulation, curves, bias, sweeps, models, parameters, libraries, AC simulation, gain, time-domain, noise, use of DesignGuides, Smith charts, S-parameters and matching networks, harmonic balance simulation, plotting data, and writing equations. Students will have developed measurement expertise completing basic measurement tasks using Keysight Network Analyzers, Signal Sources, or Signal Analyzers including, but not limited to transmission line fundamentals, measurements of cables, group delay filters, attenuators, amplifiers, mixers, and antennas. In addition, the student will have completed labs demonstrating their understanding of swept tuned analysis, power measurement, AM, FM, PM, pulsed, I and Q and other digital modulation basics.

A key component of this certification program is the use of Keysight's RF and Microwave workflow environment, a comprehensive way to simulate, measure and analyze communications components and systems. The foundations are the Keysight EEsof EDA's industry proven design tools and high-performance RF and Microwave measurement instruments. Bringing real-world measurement and test earlier into the design process enables design flaws to be captured early and corrected in a time- and cost-efficient manner, reducing overall development cost and improving design-to-manufacturing cycle time.

The Keysight RF and Microwave Industry-Ready Student Certification Program is a unique program bringing value to students, to universities, and to industry. It seeks to prepare the next generation of RF and Microwave engineers to solve the toughest electronic design challenges.

More information about the program can be found at:
https://www.keysight.com/main/editorial.jspx?cc=US&lc=eng&ckey=1733250&nid=-34360.0.00&id=1733250&cmpid=zzfindeesof-student-certification

Conclusions

The demand for sophisticated RF solutions will only continue to grow in the years ahead as we need increasing ways to communicate with and control devices on secure networks. RF technology will be the magic fueling the 5G revolution and explosion of IoT devices. Making sure engineering graduates are ready to tackle and solve the resulting RF challenges is a focus of many universities. This panel discussion explores this further while sharing how five universities make sure they are creating industry-ready engineers that can start contributing to this growth immediately upon graduation. More specifically, we will explore how industry and academia can partner together to optimize student preparedness. At the conclusion of the moderated panel discussion, attendees will be inspired to consider what industry preparedness might look like at their institutions and how their graduates are ready to tackle tomorrow's RF challenges, with some tangible ideas leveraging from the successes shared by the participating universities.