Analog and Mixed Signal Center

Short Course
November 13 – 17, 2000

TEXAS A&M UNIVERSITY
Department of Electrical Engineering
College Station, Texas 77843-3128

Course Objectives

This is the premier course on analog and mixed-signal testing. The instructors are leading experts in the field with extensive research and engineering experience in design and testing of analog and mixed-signal circuits. The course objective is to provide fundamental information on Analog and Mixed-signal Testing and practical details on testing and design for testability, which are not clearly covered in the literature or users' manuals. This knowledge is vital for
successful design and efficient test methodology. The lectures will illustrate case studies and examples used in practice. Participants will gain solid understanding of the most important aspects of analog and mixed signal testing.

Who Should Attend

This course is intended for new and experienced electric and electronic engineers who need intensive concentrated information on the state-of-the-art of Analog and Mixed-Signal Circuits Testing. In particular this course is intended for

- IC testing engineers
- Analog and Digital Circuit Designers
- Application engineers
- Developers of IC technology for mixed-model circuits

Instructors

**Gordon Roberts (S’84 – M’89)** internationally known for his work on design and testing of IC’s. Received the B.A. Sc. degree from the University of Waterloo, Canada, in 1983 and the M.A.Sc. and Ph.D. degrees from the University of Toronto, Canada, in 1986 and 1989 respectively, all in electrical engineering. Dr. Roberts is currently an associate professor in the Department of Electrical and Computer Engineering, and the Director of the Microelectronics and Computer Systems Laboratory (MACS), both at McGill University. Over the years, he has conducted extensive research on analog integrated circuit design and mixed-signal test issues. He has published over 90 papers, co-authored several textbooks related to mixed-signal test and analog integrated circuit design, and contributed 9 chapters to other books. He is past associate editor of the IEEE Transactions on Circuits and Systems, Part II, and an associate editor for the IEEE Design & Test of Computer Magazine. Prof. Roberts is a past Distinguished Lecturer for the IEEE Computer Society. He has received numerous department and faculty awards for teaching electronics to undergraduates, and received for his work on mixed-signal testing.

**Adoracion Rueda (M’87)** joined the Department of Electronics and Electromagnetism at the University of Seville in 1976 as Assistant Professor and obtained the Ph.D. degree in 1982. From now Institute of Microelectronics at Seville (IMSE). Professor in 1984 to 1996 she was Associate the Department, where she now holds the position of Professor in Electronics. In 1989, she became researcher at the Department of Analog Design of the National Research Council (CSIC). She has participated in several research projects financed by the Spanish CICYT, in the ESPRIT Projects: ADCIS, AD-2000, AMATIST, ASTERIS, MICROCARD, and SPRING, and in the AFMIS Project included in the COMETT Program of the European Community.

Her research interests are currently focussed on the topics: Design and Test of Analog and Mixed-Signal Circuits, Behavioral Modeling of Mixed-Signal Circuits and development of CAD tools.

**Mani Soma** received the B.S.E.E. degree from California State University Fresno in 1975, the M.S. and Ph.D. degrees from Stanford University in 1977 and 1980, respectively. From 1980 to 1982, he was at the General Electric Research and Development Center (Schenectady, New York), working on design and test methodologies for VLSI integrated-circuits and systems. He then joined the Department of Electrical Engineering at the University of Washington and has been a Professor since 1988. He was the Associate Director of the NSF Center for Design of Analog Digital ICs from 1989 to 1994. He founded and chaired the IEEE Mixed-Signal Test Bus Standard Working Group (1149.4) from 1991 to 1995, and remains active in standard development. He was Technical Program Chair for ISCAS 1995 and helped found the Pacific Northwest Test Workshop, which has become the annual IEEE International Mixed-Signal Testing Workshop. For these works, he received the IEEE Computer
Society Meritorious Service Award (1995) and the IEEE Computer Society Golden Core Award (1977). He has published papers in electronic design, test, and reliability; and has more recently focused on research in mixed analog-digital system design and test. He was elected IEEE Fellow “for contributions to mixed analog-digital system design-for-test.” He cooks, gardens, and teaches folk dancing in addition to electrical engineering.

Course Descriptions and General Introduction

Introduction to Mixed-Signal Test
- Main test concepts
- Terminology and approaches
- Differences between digital and analog circuit testing
- General test issues in mixed-signal circuits and design and test inter-relations
- Manufacturing, faults, parametric faults, IFA

Defect-oriented Test
- Manufacturing defects
- Classification of faults
- Fault modeling and simulation
- Defect-oriented test requirements and approaches
- The IFA technique and its feasibility for mixed-signal testing

Design for Test Techniques, Part I
- Reviews BIST and unified on-and-off-line testing techniques
- Why and how to enhance testability
- DFT options for analog and mixed-signal circuits at different hierarchy levels from layout to systems
- Some techniques for structural test of filters and data converters
- Case studies of mixed-signal test in industry and academia

Design for Test Techniques, Part II
- Testers and application issues
- Analog parametric test using digital sampling
- Delta-Sigma modulation techniques

Test Application
- Test bus standards and on-chip access
- Case studies of mixed signal test in industry and academia
- Techniques to access on-chip circuits for test, using a variety of structures from multiplexers to one-wire test bus to more complex reconfiguration schemes
- The recently approved IEEE 1149.4 Mixed-signal Test Bus Standard is described with an implementation example
- Future problems in mixed-signal and promising solutions

Test Generation and Fault Simulation Techniques
- Algorithms for automatic test generation and fault simulation for analog circuits using fault models and/or functional specifications as basis
- Some algorithms are intimately tied to specific design-for-test techniques (see previous lectures)

Case Studies and Examples
- Examples of phase-locked loops
- Examples of PWM-based power-supply circuits
Future problems in mixed-signal test, in the context of systems-on-a-chip, IP-based designs, and high-frequency RF system design

Promising techniques to solve these problems and a framework is described to evaluate these techniques

Workshop Schedule
<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
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</thead>
<tbody>
<tr>
<td>8:00 – 8:30</td>
<td>Introduction</td>
<td>Design for Test Techniques Part I (cont)</td>
<td>Test Application Part I</td>
<td>Test Application Part III</td>
<td>Challenges Ahead</td>
</tr>
<tr>
<td>8:30 -10:00</td>
<td>Introduction to Mixed-Signal Test</td>
<td>Design for Test Techniques Part I (cont)</td>
<td>Test Application Part I (cont)</td>
<td>Test Application Part III (cont)</td>
<td>Challenges Ahead</td>
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<td>10:00 – 10:30</td>
<td>BREAK</td>
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<tr>
<td>10:30 – 12:00</td>
<td>Defect-oriented Test</td>
<td>Design for Test Techniques Part I</td>
<td>Test Application Part II (cont)</td>
<td>Test Generation and Fault Simulation Techniques</td>
<td>Wrap-up and Resources</td>
</tr>
<tr>
<td>12:00 – 1:30</td>
<td>LUNCH</td>
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<tr>
<td>1:30 – 2:00</td>
<td>Defect-oriented Test</td>
<td>Design for Test Techniques Part II</td>
<td>Test Application Part II (cont)</td>
<td>Case Studies and Examples (cont)</td>
<td>Case Studies and Examples (cont)</td>
</tr>
<tr>
<td>2:00 – 3:00</td>
<td>Design for Test Techniques Part I</td>
<td>Design for Test Techniques Part II</td>
<td>Test Application Part II</td>
<td>Case Studies and Examples (cont)</td>
<td>Case Studies and Examples (cont)</td>
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<td>3:00 – 3:30</td>
<td>BREAK</td>
<td>BREAK</td>
<td>BREAK</td>
<td>BREAK</td>
<td>BREAK</td>
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<tr>
<td>3:30 – 4:30</td>
<td>Design for Test Techniques Part I</td>
<td>Design for Test Techniques Part II</td>
<td>Test Application Part II (cont)</td>
<td>Case Studies and Examples (cont)</td>
<td>Case Studies and Examples (cont)</td>
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American and Continental Airlines serve College Station through Dallas and Houston. College Station is located 90 miles north of Houston Intercontinental Airport on Texas Highway 6 via Interstate Highway 45 and State Highway 105.

A partial list of local hotels is provided below. Make reservations early. Hotels marked with (*) asterisk may provide transportation to campus if requested at check-in.

Parking fees on campus may be paid in two ways: (1) in advance by mail with registration (least cost) and (2) on a daily basis at the parking garage on a first-come-first-serve basis.

On-Campus lodging may be obtained by call the Memorial Student Center, (409) 8945-8908.

<table>
<thead>
<tr>
<th>Hotel Name</th>
<th>Address</th>
<th>Phone</th>
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<tbody>
<tr>
<td>Best Western Inn at Chimney Hill</td>
<td>901 University Dr.</td>
<td>(979) 260-9150</td>
</tr>
<tr>
<td>Comfort Inn*</td>
<td>104 Texas Ave. S.</td>
<td>(979) 846-7333</td>
</tr>
<tr>
<td>Days Inn College Station</td>
<td>2514 Texas Ave. S.</td>
<td>(979) 696-6988</td>
</tr>
<tr>
<td>Fairfield Inn</td>
<td>4613 S. Texas Ave.</td>
<td>(979) 268-1552</td>
</tr>
<tr>
<td>Hampton Inn</td>
<td>320 Texas Ave. S.</td>
<td>(979) 846-0184</td>
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<tr>
<td>Hilton Hotel*</td>
<td>801 University Dr.</td>
<td>(979) 693-7500</td>
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<tr>
<td>Holiday Inn-College Station</td>
<td>1503 Texas Ave.</td>
<td>(979) 693-1736</td>
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<tr>
<td>LaQuinta</td>
<td>607 Texas Ave. S.</td>
<td>(979) 696-7777</td>
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<tr>
<td>Ramada Inn</td>
<td>1502 Texas Ave. S.</td>
<td>(976) 693-9891</td>
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<tr>
<td>Super 8 Motel</td>
<td>301 Texas Ave.</td>
<td>(979) 846-8800</td>
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Off-Campus Lodging:
REGISTRATION FORM
Analog Mixed-Signal Center

Dept. of Electrical Engineering
Texas A&M University
College Station, Texas 77843-3128

Tel: (979) 845-9587
Fax: (979) 845-7161
E-mail: ella@ee.tamu.edu

Name ___________________________________________________________
(Last)                                                  (First/Middle)
Organization______________________________________________________
Job Title _________________________________________________________
Mail Address _____________________________________________________
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________________________________________________________________
Telephone ________________________      Fax_________________________
E-Mail __________________________________________________________

REGISTRATION FEE**        PAYMENT
One Person                        $1,400.00       Company Check (U.S. Dollars) $_____
CEU Processing Fee             $     25.00               Credit Card* (circle one)
(SS#__________________)                                Master Card       Visa          AmEx
On-Campus Parking                                      Name as it appears on the card:
$6 per day x____ days      $______             __________________________________________
TOTAL       $______             Card #__________________________
** Discounts available                                 Exp. Date _______________________
For companies associated to the
Analog and Mixed Signal Center
Mail registration form with payment to:     Continuing Education Units (CEU
AMSC, Texas A&M University)                are available upon request by marking
ATTN: Ella Gallagher                                 the appropriate box on the registration
Dept. of Electrical Engineering                   form and submitting the fee. Completing
College Station, TX 77843-3128 USA       the course will earn 1.4 CEU’s.

Cancellation Policy | Guaranteed
Registration deadline is October 24
After Oct. 24, registration is on a First-come-first-serve basis only.
Registration fees will be refunded,
Less a cancellation fee of $200, if Written cancellation request is received on or before Nov. 1.
TAMU reserves the right to cancel
The course, if necessary, due to low registration before Nov 5 and will provide full refund of paid registration fees.

Internet Information
This Course:
http://amsc.tamu.edu/shortcourses
Other Courses: (to be confirmed)
RF Communication Circuits
Low Voltage Analog Circuit Design
Analog to Digital Converters
Continuous-Time and Discrete-Time IC Filters
Discounts: for AMSC industrial partners.