

THE UNIVERSITY OF TEXAS AT DALLAS

ALLAS Erik Jonsson School of Engineering and Computer Science Department of Electrical Engineering

# EEDG/CE 6303: Testing and Testable Design

(Spring 2015, Tuesday and Thursday: 5:30-6:45 p.m., ECSS 2.201)

## 1 General Information

Instructor:	Mehrdad Nourani
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E-mail (Webpage):	nourani@utdallas.edu (http://www.utdallas.edu/~nourani)
Office Hours:	Tuesday and Thursday 4:00-5:00 p.m., or by appointment.
Required Texts:	Testing of Digital Systems, Niraj Jha and Sandeep Gupta,
	Cambridge University Press, 2003.
Other References:	VLSI Test Principles and Architectures, L-T Wang, C-W Wu and X. Wen,
	Morgan Kaufmann, 2006.
	Essentials of Electronic Testing, Michael Bushnell and Vishwani Agrawal,
	Kluwer Academic Publishers, 2000.
Course Web Page:	http://elearning.utdallas.edu/
Teaching Assistant:	To be announced.

## 2 Catalog Description

#### EEDG/CE 6303 Testing and Testable Design (3 semester hours).

Fault modeling, fault simulation, testing the stuck at faults, automatic test generation, random test generation, testing the bridging faults, functional testing, design for testability, full/partial scan, boundary scan, compression techniques, built in self test, BIST architectures, PLA/memory testing, core testing, system-level testing.

Prerequisite: Digital design (e.g. EE 3320) and basic knowledge of computer architecture, VLSI and HDL.

## 3 Course Objective

The objective of this graduate level course is to introduce the testing methodologies for VLSI circuits and digital systems. We provide students with access to the CAD tools to use hardware description language to model, and perform fault simulation/analysis and test insertion for various digital circuits/systems. It is expected that the students will acquire a clear understanding of the main test strategies and the optimizations techniques for fault modeling, structural analysis, test pattern generation and design for testability. In particular, the following are the course learning objectives:

- CLO1: Understand the basic process and economics of VLSI testing and be able to work with failure mechanisms, fault models and fault simulations.
- CLO2: Ability to apply test pattern generation algorithms to combinational and sequential circuits.
- CLO3: Ability to apply algorithms for delay fault testing and memory test.
- CLO4: Understand the concepts and be able to apply design-for-test methodologies (scan and built-in-self test).
- CLO5: Ability to use hardware description languages and CAD tools for fault simulation, test pattern generation and test analysis

## 4 Grading

Grading will be based on two tests and homeworks as follows:

			$85 \le A - < 93$	$93 \le A \le 100$	
HWs/Projects:	25%		$70 \le B - < 75$	$75 \le B < 80$	$80 \le B + < 85$
Test 1:	35%	(Tues. 3/3/2015, 5:30 pm.)	$60 \le C < 65$	$65 \le C + < 70$	
Test 2:	40%	(Thurs. 4/30/2015, 5:30 pm.)	$0 \le F < 60$		

Note: Per UTD requirements for M.S. degrees, a minimum grade of B- in each and a minimum GPA of 3.0 for all "core" courses are required.

## 5 Course Policy

• Homeworks will be assigned throughout the semester, and will be due approximately once every two weeks at 5:30 p.m. at the **beginning** of the lecture period. Homeworks cannot be submitted by email or fax.

- A homework is considered **late** if it is turned in after 5:30 p.m. of the due date. There will be 20% per day penalty for late homeworks up to 3 days excluding weekends and holidays. Late homeworks and reports won't be accepted after 3 days.
- No makeup examinations/Quizzes/homeworks will be offered in this course. Any graded work can be disputed in writing within one week of the return of that work. In such cases, the entire work will be regraded.
- Some of the homeworks are mini-projects and require C-programming or using CAD tools for implementation, simulation and analysis. These tools are available on almost all Unix machines in ECSN building such as Solarium Lab (ECSN 4.324) and through remote login (e.g. using NX Client or Xmanager) on machines in the ECS open lab (ECSS2.104). To have enough time start as early as possible.
- Copying on examinations, assignments and projects is cheating and is prohibited. Any instances of cheating or plagiarism is considered academic dishonesty and will be subject to disciplinary penalties according to the UT Dallas policy on scholastic dishonesty. The penalties include the possibility of failure in the course and/or dismissal from the University. Since such dishonesty harms the individual, all students and the integrity of the University, policies on scholastic dishonesty will be strictly enforced. Please read carefully this policy in http://www.utdallas.edu/deanofstudents/dishonesty/.
- Make-up tests will not be given unless the student has obtained permission from the instructor **before** the scheduled test. Permission will not be given without documentation of exceptional circumstances.
- If a student has to be absent for several classes, e.g. because of job related obligations, (s)he will not be eligible for an incomplete grade. In such cases, the student is advised to withdraw the course.
- Announcements, homeworks and complementary materials will be posted on the course web page. It is the responsibility of each student to check this web page regularly. Regular attendance and taking notes are highly recommended.

Weeks		Readings	Topics Coverage	
Tues.	Thur.			
1/13		Ch 1	Introduction: course introduction; test technology evolution; cost of testing;	
	1/15		linking design and test.IC testing: VLSI fabrication; testing at the IC level.	
1/20		Ch 1	VLSI testing process: test process; automatic test equipment;	
	1/22		Test economics: cost analysis; rule of ten; test data analysis; quality measure.	
1/27		Ch 2	Fault modeling: failure mechanisms and characteristics; fault detection	
	1/29		and redundancy; fault equivalence and dominance; fault models.	
2/3		Ch 3	Fault simulation techniques: serial, parallel, deductive and concurrent	
	2/5		fault simulations; fault sampling; statistical fault analysis.	
2/10		Ch 4	Test generation for combinational circuits: boolean difference;	
	2/12		D-algorithm; PODEM algorithm; FAN algorithm; testing the bridging faults;	
2/17		Ch 5	Test generation for sequential circuits: single clock synchronous model;	
	2/19		time-frame expansion method; difficulties in sequential circuit testing.	
2/24		Ch 8	Delay test: path delay testing; transition faults; at-speed testing.	
	2/26			
3/3			<b>TEST 1</b> (selected topics of Ch 1–5 and 8).	
	3/5	Ch 14	Memory test: memory density and defects;	
3/10		Ch 14	memory fault modeling;	
	3/12		March algorithms; testing RAM, ROM and cache.	
3/17			Spring Break – University Holiday	
	3/19			
3/24		Ch 11	Design for testability: controllability and observability metrics;	
	3/26		Boundary scan: full and partial scan;	
3/31		Ch 11	boundary scan standard; ad-hoc methods; variations of scan;	
	4/2			
4/7			TAP Controller; test instructions BSD Language;	
	4/9	Ch 12	Built-in self-test: BIST concept; test pattern generation for BIST;	
4/14		Ch 12	compression techniques; various BIST architectures; test point selection;	
	4/16		memory BIST; delay fault BIST;	
4/21		Ch 6	IDDQ test: target faults; testing methods; fault coverage metrics; current limit setting;	
	4/23		System test and core based design: using embedded microprocessor in testing;	
4/28		literature	core-based design and test; SoC test architecture; test for signal integrity;	
	4/30		<b>TEST 2</b> (selected topics of Ch 6, 11, 12, 14, 16 and literature).	

## 6 Syllabus & Tentative Lecture Plan

Note: Some topics in this course syllabus are not fully covered in any text book.

## 7 Field Trip Policies

#### **Off-campus Instruction and Course Activities**

Off-campus, out-of-state, and foreign instruction and activities are subject to state law and University policies and procedures regarding travel and risk-related activities. Information regarding these rules and regulations may be found at the website address http://www.utdallas.edu/deanofstudents/travel. Additional information is available from the office of the school dean. Below is a description of any travel and/or risk-related activity associated with this course.

### 8 Student Conduct & Discipline

The University of Texas System and The University of Texas at Dallas have rules and regulations for the orderly and efficient conduct of their business. It is the responsibility of each student and each student organization to be knowledgeable about the rules and regulations which govern student conduct and activities. General information on student conduct and discipline is contained in the UTD publication, A to Z Guide, which is provided to all registered students each academic year.

The University of Texas at Dallas administers student discipline within the procedures of recognized and established due process. Procedures are defined and described in the Rules and Regulations, Board of Regents, The University of Texas System, Part 1, Chapter VI, Section 3, and in Title V, Rules on Student Services and Activities of the university's Handbook of Operating Procedures. Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations (SU 1.602, 972/883-6391).

A student at the university neither loses the rights nor escapes the responsibilities of citizenship. He or she is expected to obey federal, state, and local laws as well as the Regents' Rules, university regulations, and administrative rules. Students are subject to discipline for violating the standards of conduct whether such conduct takes place on or off campus, or whether civil or criminal penalties are also imposed for such conduct.

### 9 Academic Integrity

The faculty expects from its students a high level of responsibility and academic honesty. Because the value of an academic degree depends upon the absolute integrity of the work done by the student for that degree, it is imperative that a student demonstrate a high standard of individual honor in his or her scholastic work.

Scholastic dishonesty includes, but is not limited to, statements, acts or omissions related to applications for enrollment or the award of a degree, and/or the submission as one's own work or material that is not one's own. As a general rule, scholastic dishonesty involves one of the following acts: cheating, plagiarism, collusion and/or falsifying academic records. Students suspected of academic dishonesty are subject to disciplinary proceedings.

Plagiarism, especially from the web, from portions of papers for other classes, and from any other source is unacceptable and will be dealt with under the university's policy on plagiarism (see general catalog for details). This course will use the resources of turnitin.com, which searches the web for possible plagiarism and is over 90% effective.

### 10 Email Use

The University of Texas at Dallas recognizes the value and efficiency of communication between faculty/staff and students through electronic mail. At the same time, email raises some issues concerning security and the identity of each individual in an email exchange. The university encourages all official student email correspondence be sent only to a student's U.T. Dallas email address and that faculty and staff consider email from students official only if it originates from a UTD student account. This allows the university to maintain a high degree of confidence in the identity of all individual corresponding and the security of the transmitted information. UTD furnishes each student with a free email account that is to be used in all communication with university personnel. The Department of Information Resources at U.T. Dallas provides a method for students to have their U.T. Dallas mail forwarded to other accounts.

### 11 Withdrawal from Class

The administration of this institution has set deadlines for withdrawal of any college-level courses. These dates and times are published in that semester's course catalog. Administration procedures must be followed. It is the student's responsibility to handle withdrawal requirements from any class. In other words, I cannot drop or withdraw any student. You must do the proper paperwork to ensure that you will not receive a final grade of "F" in a course if you choose not to attend the class once you are enrolled.

## 12 Student Grievance Procedures

Procedures for student grievances are found in Title V, Rules on Student Services and Activities, of the university's Handbook of Operating Procedures.

In attempting to resolve any student grievance regarding grades, evaluations, or other fulfillments of academic responsibility, it is the obligation of the student first to make a serious effort to resolve the matter with the instructor, supervisor, administrator, or committee with whom the grievance originates (hereafter called "the respondent"). Individual faculty members retain primary responsibility for assigning grades and evaluations. If the matter cannot be resolved at that level, the grievance must be submitted in writing to the respondent with a copy of the respondent's School Dean. If the matter is not resolved by the written response provided by the respondent, the student may submit a written appeal to the School Dean. If the grievance is not resolved by the School Dean's decision, the student may make a written appeal to the Dean of Graduate or Undergraduate Education, and the deal will appoint and convene an Academic Appeals Panel. The decision of the Academic Appeals Panel is final. The results of the academic appeals process will be distributed to all involved parties.

Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations.

### **13** Incomplete Grade Policy

As per university policy, incomplete grades will be granted only for work unavoidably missed at the semester's end and only if 70% of the course work has been completed. An incomplete grade must be resolved within eight (8) weeks from the first day of the subsequent long semester. If the required work to complete the course and to remove the incomplete grade is not submitted by the specified deadline, the incomplete grade is changed automatically to a grade of F.

### 14 Disability Services

The goal of Disability Services is to provide students with disabilities educational opportunities equal to those of their non-disabled peers. Disability Services is located in room SSB 3.200 in the Student Union. Office hours are Monday through Thursday, 8:00 a.m. to 6:00 p.m.; and Friday, 8:00 a.m. to 5:00 p.m. The contact information for the Office of Disability Services is:

Student AccessAbility, SSB3.200 The University of Texas at Dallas 800 W. Campbell Rd., SSB32 Richardson, TX 75080 972-883-2098 Office 972-883-6561 Fax studentaccess@utdallas.edu

Essentially, the law requires that colleges and universities make those reasonable adjustments necessary to eliminate discrimination on the basis of disability. For example, it may be necessary to remove classroom prohibitions against tape recorders or animals (in the case of dog guides) for students who are blind. Occasionally an assignment requirement may be substituted (for example, a research paper versus an oral presentation for a student who is hearing impaired). Classes enrolled students with mobility impairments may have to be rescheduled in accessible facilities. The college or university may need to provide special services such as registration, note-taking, or mobility assistance.

It is the student's responsibility to notify his or her professors of the need for such an accommodation. Disability Services provides students with letters to present to faculty members to verify that the student has a disability and needs accommodations. Individuals requiring special accommodation should contact the professor after class or during office hours.

## 15 Religious Holy Days

The University of Texas at Dallas will excuse a student from class or other required activities for the travel to and observance of a religious holy day for a religion whose places of worship are exempt from property tax under Section 11.20, Tax Code, Texas Code Annotated. The student is encouraged to notify the instructor or activity sponsor as soon as possible regarding the absence, preferably in advance of the assignment. The student, so excused, will be allowed to take the exam or complete the assignment within a reasonable time after the absence: a period equal to the length of the absence, up to a maximum of one week. A student who notifies the instructor and completes any missed exam or assignment may not be penalized for the absence. A student who fails to complete the exam or assignment within the prescribed period may receive a failing grade for that exam or assignment. If a student or an instructor disagrees about the nature of the absence [i.e., for the purpose of observing a religious holy day] or if there is similar disagreement about whether the student has been given a reasonable time to complete any missed assignments or examinations, either the student or the instructor may request a ruling from the chief executive officer of the institution, or his or her designee. The chief executive officer or designee must take into account the legislative intent of TEC 51.911(b), and the student and instructor will abide by the decision of the chief executive officer or designee.