Syllabus for
EEL 5934 - Introduction to Hardware Security and Trust
Spring 2017

1. Catalog Description

Fundamentals of hardware security and trust for integrated circuits. Cryptographic hardware, invasive and non-invasive attacks, side-channel attacks, physically unclonable functions (PUFs), true random number generation (TRNG), watermarking of Intellectual Property (IP) blocks, FPGA security, counterfeit ICs, hardware Trojans in IP cores and ICs. Lecture. Credits 3.

2. Pre-requisites

EEL3701C: Digital Logic (or equivalent)

3. Course Objectives

This course will cover the following topics: Cryptographic processor and processing overhead analysis, physical and invasive attacks, side-channel attacks, physically unclonable functions, hardware-based true random number generators, watermarking of Intellectual Property (IP) blocks, FPGA security, passive and active metering for prevention of piracy, access control, hardware Trojan detection and isolation in IP cores and integrated circuits (ICs). The course is largely self-contained. Background on digital design would be sufficient. Introductory lectures will cover basic background on cryptography, authentication, secret sharing, VLSI design, test and verification. The main goals for this course are:

- Learning the state-of-the-art security methods and devices
- Integration of security as a design metric, not as an afterthought
- Protection of the design intellectual property against piracy and tampering
- Better understanding of attacks and providing countermeasures against them
- Detection and isolation of hardware Trojans
- Counterfeit Electronics: Detection and Prevention

4. Instructors/coordinators:

	Dr. Swarup Bhunia	**Dr. Mark Tehranipoor**
Office Location	MAE 226 C	MAE 226 B
Office Hours	Wed 4-5pm	Mon 3-4pm
Telephone	352-392-5989	352-392-2585
Email	swarup@ece.ufl.edu	tehranipoor@ece.ufl.edu
Website	http://swarup.ece.ufl.edu	http://tehranipoor.ece.ufl.edu

5. Supervised Teaching Assistants (STAs)

Robert Karam: robkaram@ufl.edu (TBD)
Shuo Yang: sy@ufl.edu (Fri 4-5pm)
Fahim Rahman: fahim034@ufl.edu (Wed 3-4pm)
The STAs will lead about half of the Thursday lectures and will assist with evaluation of student modules and final projects.

6. Meeting Times

Days	**Period**	**Time**
Tuesday	08-09	3:00-4:55PM
Thursday	09	4:05-4:55PM

7. Meeting Location (for In-campus students) - NEB 201

8. Material and Supply Fees

Avnet Spartan-6 LX9 MicroBoard for each project team ($~100/team) – each team may include up to 3 students. (https://www.xilinx.com/products/boards-and-kits/1-3i2dfk.html)

9. Textbooks and Software Required

Textbook: None

Recommended Reference Book:

M. Tehranipoor and C. Wang (Eds.), Introduction to Hardware Security and Trust, *Springer*, 2011

Software: Xilinx ISE package, Synopsys Verilog simulation package and HSpice, Cadence Design System, Programming and Scripting Software (Matlab, Python, C/C++)

10. Recommended Reading and Videos

Reading

- Mihir Bellare and Phil Rogaway, Introduction to Modern Cryptography
- Ross J. Anderson. Security Engineering: A guide to building dependable distributed systems. John Wiley and Sons, 2001
- Matt Bishop , Computer Security: Art and Science, Addison-Wesley, 2003
- William Stallings. Cryptography and Network Security, Fourth edition, 2007 (WS)
- The Hunt for the Kill Switch
- Hardware Trojan (computing)
- Defense Science Board Task Force On High Performance Microchip Supply
- Old Trick Threatens the Newest Weapons
- A Survey of Hardware Trojan taxonomy and Detection
- Detecting malicious inclusions in secure hardware: Challenges and Solutions
- FPGA Design Security Bibliography
- Supergeek pulls off 'near impossible' crypto chip hack
- Security through obscurity
- Trust-Hub

Videos

- What's inside a microchip? http://www.youtube.com/watch?v=GdqbLmdKgw4
- Zoom Into a Microchip http://www.youtube.com/watch?v=Fxv3JoS1uY8
- Public Key Cryptography: RSA Encryption: http://www.youtube.com/watch?v=wXB-V_Keiu8
- Counterfeit Electronics Could Be Dangerous, Funding Nefarious People http://www.youtube.com/watch?v=dbZiUe6guxc
- How Computers and Electronics Are Recycled http://www.youtube.com/watch?v=Iw4g6H7alvo
- Counterfeit Electronic Components Process http://www.youtube.com/watch?v=5vN_7NJ4qYA
- Counterfeit Inspection http://www.youtube.com/watch?v=MbQUvu2LN6o
- Gold from waste circuit electronics http://www.youtube.com/watch?v=ZkhOuNvkuu8
- Tarnovsky Deconstruct Processor https://www.youtube.com/watch?v=w7PT0nrK2BE

11. Course Outline

Week	Tuesday Lecture	Instructor	Thursday Lecture	Instructor
Week 1 (Jan 5)	-	-	Syllabus, Ethics, Introduction to hardware security and trust, Emerging applications and the new threats	SB
Week 2 (Jan 10, 12)	Introduction to Cryptography	SB	Introducing Thursday Activities + VHDL/Verilog & FPGA Tutorial	STA
Week 3 (Jan 17, 19)	Basics of VLSI Design and Test	SB	VHDL/Verilog & FPGA Tutorial	STA

Week 4 (Jan 24, 26)	Security Based on Physically Unclonability and Disorder	SB	VHDL/Verilog & FPGA Tutorial	STA
Week 5 (Jan 31, Feb 2)	Hardware Metering	SB	VHDL/Verilog & FPGA Tutorial + Project Description	STA
Week 6 (Feb 7, 9)	Watermarking of HW IPs	SB	Student Presentations	SB/STA
Week 7 (Feb 14, 16)	Physical Attacks and Tamper Resistance	SB	Student Presentations	SB/STA
Week 8 (Feb 21, 23)	Security in Embedded Systems + **Midterm**	SB	Student Presentations	SB/STA
Week 9 (Feb 28, Mar 2)	Fault Injection Attacks, Security of RFID Tags	SB	Student Presentations	SB/STA
Week 10	SPRING BREAK			
Week 11 (Mar 14, 16)	Protecting against Scan-based Side Channel Attacks	SB	Student Presentations	SB/STA
Week 12 (Mar 21, 23)	Basics of PCB Security	SB	Student Presentations	SB/STA
Week 13 (Mar 28, 30)	Hardware Trojans: IC Trust (Taxonomy and Detection)	SB	Student Presentations	SB/STA
Week 14 (Apr 4, 6)	Counterfeit Detection and Avoidance	SB	Student Presentations	SB/STA
Week 15 (Apr 11, 13)	Hardware Trojans: IP Trust (Detection) + Design for Hardware Trust	SB	Student Presentations	SB/STA
Week 16 (Apr 18)	Side Channel Attacks and Countermeasures, Countermeasures for Embedded Microcontrollers	SB	Reading day	

12. Attendance and Expectations

Format: The course is comprised of weekly lectures, 3-4 HW assignments, student paper presentation module, and a final project. In addition, there will be two exams (midterm + final).

Students must submit ***individual*** work ***individually*** on each module and as a team of 3/4 on paper presentation and final project. You are encouraged to work together on homework assignments and share ideas on lab assignments. However, you are not allowed to copy or duplicate any lab material (code, drawings, etc.) from another student. This work will be considered cheating and will be dealt with in a severe manner. See Section 16 on Honesty Policy.

The final project will require implementation of a hardware security primitive or attack on an FGPA based on several conference and journal papers distributed to the teams. The team's work will be evaluated through demonstration on several benchmarks. Each group will prepare a presentation, demonstration of the project, and final report. The final report will discuss challenges met, present in-depth analysis of the approaches implemented by the team, etc.

For EDGE students the student presentation and class project need to be individual (not group) work. The amount of work needed for these two components will be appropriate for individual contribution. Additional details on project and student presentation will be provided later in the class.

13. Grading-methods of evaluation

- Exams 45% (20% mid-term, 25% final (comprehensive))
- HW Assignments 15%
- Final Project 20%
- Oral Paper Presentation 20%

14. Grading Scale

Grading scale for the course: ≥90 A, ≥87 A-, ≥80 B, ≥77 B-, ≥ 70 C,≥ 67 C-,≥ 60 D, ≥ 57 D-,<57 F

15. Make-up Exam Policy

For the pass/fail evaluation of each module, students are allowed two tardy passes where a tardy is any module checked-off after the initial scheduled time. The tardy extension can be up to one week only and if a student falls too far behind they will be strongly encouraged to drop the class. After the first two free tardy extensions are used, additional tardy extensions result in a partial grade penalty – i.e. A=>A-…C-=>D+, one grade lower automatically per unsanctioned tardy.

16. Honesty Policy

All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

17. Accommodation for Students with Disabilities

Students requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

18. UF Counseling Services

Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:
University Counseling Center, 301 Peabody Hall, 392-1575, Personal and Career Counseling.
SHCC mental Health, Student Health Care Center, 392-1171, Personal and Counseling.
Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161, sexual assault counseling.
Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling.

19. Software Use

All faculty, staff and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.