NC STATE UNIVERSITY

ECE 745: ASIC Verification
Spring 2024
3 Credit Hours

Instructor: Robert D. Oden
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Course:

Class Location: EB3-02124
Class Schedule on Fridays:
1:30pm-4:15pm
Office Hours:
After class on Fridays.
Other times available upon request via zoom.
Delivery:
Moodle will be used for all tests, project submissions, course materials, question forums, and access to lecture recording links.
TA's:
Adithya Simha – @ncsu.edu
Mehul Nachankar – @ncsu.edu

Textbook:
"SystemVerilog for Verification - A Guide to Learning the Testbench Features"
Chris Spear, Greg Tumbush
Springer, 2012. ISBN 978-1-4614-0714-0, e-ISBN 978-1-4614-0715-7
Approximate price $68

Prerequisite:
ECE 564, ASIC and FPGA Design with Verilog, or equivalent.

Course Description

This course covers the technologies, techniques, and methodologies used to verify functional correctness of digital logic. SystemVerilog, IEEE-1800, is the language used in this course to create class based simulation environments that use object oriented programming techniques, constrained randomization, and functional coverage to find bugs in digital designs. This course is the prerequisite for ECE 748, "Advanced Verification using UVM".

Course Objectives

1. To make the student proficient in the industry standard language used for functional verification, SystemVerilog.
2. To give the student the ability to architect and implement layered, class based, simulation environments.

3. To prepare the student for learning the industry standard methodology used for functional verification, UVM.

Course Outcomes

By the end of the course students will be able to:

1. Verify complex digital designs at block and chip level, identifying the contained bugs, and closing functional coverage, using SystemVerilog.
2. Explain the purpose and design of base class packages used in functional verification.
3. Use a base class package to create layered test benches used in ASIC and FPGA Verification and their implementation using SystemVerilog.

Course Approach:

The course approach is similar to how the instructor teaches SystemVerilog to engineering professionals. All instructional material will be delivered during lectures. Lecture materials will include conceptual descriptions, examples, and sample code. Questions during lectures is recommended and encouraged. Instructional flow reflects typical verification development flow for production designs.

The course contains four projects. The projects build upon each other. The content created in the first project will be used in the second project. The content created in the second project will be used in the third project. The content used in the third project will be used in the fourth project. All concepts required for project development will be covered during lectures. Students will have approximately four weeks to complete each project. Projects will be done individually. Projects will reflect architectures and techniques typically used for ASIC and FPGA verification of production designs.

The course contains three tests. The first test will be held in week 4 or soon thereafter. The second test will be held in week 8 or soon thereafter. Test questions reflect typical interview questions on SystemVerilog. Therefore, tests are closed book and closed-notes.

Project Schedule

Project	Description	Date Assigned	Due Date	#Weeks
1	Creating interfaces to generate signal level activity	Week 3	Week 7	4
2	Creating a layered test bench using classes to generate transaction level activity	Week 7	Week 11	4
3	Creating a Test Plan. Adding randomization and coverage to the layered test bench	Week 11	Week 12	1
4	Adding tests to the layered test bench to close coverage and find design bugs	Week 12	Week 15	3

Test Schedule

Test	Description	Date
1	Basic SystemVerilog language constructs, Data types, procedural statements, interfaces	Week 4
2	Object Oriented Programming techniques using SystemVerilog, using classes to create layered test bench, threads, inter-process communication	Week 9
3	Constrained randomization, functional coverage, UVM introduction	Week 16 (Finals week)

Student Evaluation

Item	Contribution
Test 1	10%
Test 2	10%
Test 3	10%
Project 1	15%
Project 2	25%
Project 3	15%
Project 4	15%
Total	100%

Grading based on standard NCSU 10% scale

Class Schedule

- Week 1 – 1/13
  - Lecture 1 Presentation Topics: Verification guidelines.
  - Lecture recording date: 1/14/2022
- Week 2 – 1/20
  - Lecture 2 Presentation Topics: Data types, procedural statements
  - Lecture recording date: 1/28/2022
- Week 3 – 1/27
  - Lecture 3 Presentation Topics: Interfaces, TB-DUT connection, scheduling
  - Lecture recording date: 1/28/2022
  - Project 1 assignment – Interfaces
- Week 4 – 2/3
  - Test 1 – Data types, interfaces, procedural statements, scheduling
- Week 5 – 2/10
  - Lecture 6 Presentation Topics: Threads, inter-process communication
  - Lecture recording date: 2/11/2022
- Week 6 – 2/17
  - Lecture 4 Presentation Topics: Basic OOP
  - Lecture recording date: 2/18/2022
- Week 7 – 2/24
  - Project 1 due in Moodle at 11:59pm
  - Lecture 5 Presentation Topics: Advanced OOP, layered test bench

    - Lecture recording date: 2/25/2022
    - Project 2 assignment – Layered test bench
- Week 8 – 3/3
    - Guest Lecture: Harry Foster – Siemens EDA. Verification trends, SVA
- Week 9 – 3/10
    - Test 2 – OOP, layered test bench, threads, IPC
- Week 10 – 3/17
    - Spring Break – No class
- Week 11 – 3/24
    - Project 2 Due in Moodle at 11:59pm
    - Lecture 7 Presentation Topics: Test plan
    - Lecture 8 Presentation Topics: Functional coverage
    - Lecture recording date: 3/25/2022
    - Project 3 assignment – Test plan, randomization, and coverage
- Week 12 – 3/31
    - Lecture 9 Presentation Topics: Randomization
    - Lecture 10 Presentation Topics: UVM introduction
    - Lecture recording date: 4/1/2022
    - Project 3 due in Moodle at 11:59pm
    - Project 4 assignment – Randomization and coverage
- Week 13 – 4/7
    - Guest Lecture: Josh Rensch – Semifore Inc.
- Week 14 – 4/14
    - Guest Lecture: Ameen Ashraf – Meta Inc.
- Week 15 – 4/21
    - Project 4 due in Moodle 4/24 at 11:59pm
- Week 16 – 4/29 (Finals)
    - Test 3 – Randomization, functional coverage, UVM introduction

Late Assignment Policy:

Instructor will consider reasonable requests for due date delays for legitimate reasons. Late assignments will be assessed a 3% penalty per day after due date.

Attendance Policy:

Attendance is recommended but not required. Class lectures are recorded and available for review. For more information on NC State's policy on attendance, please see the "Attendance Regulations (REG 02.20.03)" at https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations.

Public Health Policy:

Due to the Coronavirus pandemic, public health measures have been implemented across campus. Students should stay current with these practices and

expectations through the Protect the Pack website (https://www.ncsu.edu/coronavirus/). The sections below provide expectations and conductrelated to COVID-19 issues.

Health and Participation in Class

We are most concerned about your health and the health of your classmates and instructors/TAs.

- If you test positive for COVID-19, or are told by a healthcare provider that you are presumed positive for the virus, please work with your instructor on health accommodations and follow other university guidelines, including selfreporting: https://healthypack.dasa.ncsu.edu/coronavirus/. Self-reporting is not only to help provide support to you, but also to assist in contact tracing for containing the spread of the virus.
- If you feel unwell, even if you have not been knowingly exposed to COVID-19, please do not come to class.
- If you are in quarantine, have been notified that you may have been exposed to COVID-19, or have a personal or family situation related to COVID-19 that prevents you from attending this course in person (or synchronously), please connect with your instructor to discuss the situation and make alternative plans, as necessary.
- If you need to make a request for an academic consideration related to COVID-19, such as a discussion about possible options for remote learning, please talk with your instructor for the appropriate process to make a COVID-19 request.

Health and Well-Being Resources

These are difficult times, and academic and personal stress is a natural result. Everyone is encouraged to take care of themselves and their peers. If you need additional support, there are many resources on campus to help you:

- Counseling Center (https://counseling.dasa.ncsu.edu/)
- Health Center (https://healthypack.dasa.ncsu.edu/)
- If the personal behavior of a classmate concerns or worries you, either for the classmate's wellbeing or yours, we encourage you to report this behavior to the NC State CARES team: (https://advising.dasa.ncsu.edu/resources-for-advisors/advisors-toolkit/cares/)
- If you or someone you know are experiencing food, housing or financial insecurity, please see the Pack Essentials Program (https://dasa.ncsu.edu/pack-essentials/).

Community Standards related to COVID-19

We are all responsible for protecting ourselves and our community. Please see the community expectations (link TBD) and Rule 04.21.01 regarding Personal Safety Requirements Related to COVID-19 https://policies.ncsu.edu/rule/rul-04-21-01/

Course Expectations Related to COVID-19:

• Personal Protective Equipment: As a member of the NC State academic community you are required to follow all university guidelines for personal safety with face coverings, physical distancing, and sanitation. Face coverings are required in this class and in all NC State buildings. Face coverings should be worn to cover the nose and mouth and be close fitting to the face with minimal gaps on the sides. In addition, students are responsible for keeping their course/work area clean.
• Course Attendance: NC State attendance policies can be found at: https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations/ . Please refer to this course's attendance, absence, and deadline policies for additional details. If you are quarantined or otherwise need to miss class because you have been advised that you may have been exposed to COVID-19, you should not be penalized regarding attendance or class participation. However, you will be expected to develop a plan to keep up with your coursework during any such absences. If you become ill with COVID-19, you should follow the steps outlined in the health and participating section above. COVID 19-related absences will be considered excused; documentation need only involve communication with your instructor.
• Course Meeting Schedule: Your course might not have a traditional meeting schedule in Fall 2020. Be sure to pay attention to any updates to the course schedule as the information in this syllabus may have changed. Please discuss any questions you have with the instructor.
• Classroom Seating: To support efficient, effective contact tracing, please sit in the same seat when possible and take note of who is sitting around you; instructors may also assign seats for this purpose..
• Technology Requirements: This course may require particular technologies to complete coursework. Be sure to review the syllabus for these expectations, and see go.ncsu.edu/syllabustech-requirements to find out more about technical requirements for your course. If you need access to additional technological support, please contact the Libraries' Technology Lending Service: https://www.lib.ncsu.edu/devices.

Course Delivery Changes Related to COVID-19

Please be aware that the situation regarding COVID-19 is frequently changing, and the delivery mode of this course may need to change accordingly, including from in-person to online. Regardless of the delivery method, we will strive to provide a high-quality learning experience.

Grading/Scheduling Changing Options Related to COVID-19

If the delivery mode has a negative impact on your academic performance in this course, the university has provided tools to potentially reduce the impact:

• Enhanced S/U Grading Option: https://studentservices.ncsu.edu/your-resources/covid- 19/spring2020-sat-grading/
• Late Drop: https://studentservices.ncsu.edu/your-resources/covid-19/spring2020-latedrop/

In some cases, another option may be to request an incomplete in the course. Before using any of these tools, discuss the options with your instructor and your academic advisor. Be aware that if you use the enhanced S/U, you will still need to complete the course and receive at least a C- to pass the course.

Other Important Resources

- Keep Learning: https://dasa.ncsu.edu/students/keep-learning/
- Protect the Pack FAQs: https://www.ncsu.edu/coronavirus/frequently-asked-questions/
- NC State Protect the Pack Resources for Students: https://www.ncsu.edu/coronavirus/reactivating-campus/resources-for-students/
- NC State Keep Learning, tips for students opting to take courses remotely: https://dasa.ncsu.edu/students/keep-learning/
- Introduction to Zoom for students: https://youtu.be/5LbPzzPbYEw
- Learning with Moodle, a student's guide to using Moodle: https://moodle-projects.wolfware.ncsu.edu/course/view.php?id=

Academic Integrity:

Please review the Code of Student Conduct: https://studentconduct.dasa.ncsu.edu/code/

Aiding and Abetting:

Students may not provide or post any test, example, or project solution online without written consent of the instructor. The Code of Conduct regarding aiding and abetting is provided below. Failure to comply will expose you to a possible academic integrity charge of abetting copying, including the possibility of a retroactive grade penalty.

8.1 AIDING AND ABETTING

Aiding and abetting others to cheat or plagiarize is as detrimental to the scholarly community as engaging in the acts themselves. Aiding and abetting others to cheat or plagiarize includes, but is not limited to, the following:

(a) Giving unauthorized assistance to another or others during a test or evaluation;

(b) Posing as another student in order to meet a course or graduation requirement;

(c) Providing specific information about a recently given test, examination, or assignment to a student who thereby gains an unfair advantage in an academic evaluation;

(d) Providing aid to another person, knowing such aid is expressly prohibited by the faculty member, in the research, preparation, creation, writing, performing, or publication of work to be submitted for academic evaluation;

(e) Permitting one's academic work to be represented as the work of another; or

(f) Sharing or distributing academic materials, including class notes, in violation of the **UNC Policy Manual 500.2 – Patent and Copyright Policies** or **NCSU REG01.25.02 – Copyright Infringement – Policy Statement**.

Plagiarism:

The Code of Conduct regarding plagiarism is provided below. Failure to comply will expose you to a possible academic integrity charge of plagiarism, including the possibility of a retroactive grade penalty.

8.4 PLAGIARISM

Plagiarism is the use or close imitation of the language and thoughts of another and the representation of the other's work as their own. The act of submitting work for evaluation or to meet a requirement is regarded as assurance that the work is the result of the student's own thought and study, produced without assistance, and stated in that student's own words, except as quotation marks, references, or footnotes acknowledge the use of other sources. Any ideas or materials taken from another source for either written or oral use must be fully and correctly acknowledged. Submission of work used previously must first be approved by the faculty member. Plagiarism includes, but is not limited, to the following actions:

(a) Representing the work of others as his or her own; or

(b) Submitting written materials without proper attribution or acknowledgment of the source.

Cheating:

The Code of Conduct regarding cheating is provided below. Failure to comply will expose you to a possible academic integrity charge of cheating.

8.2 CHEATING

Cheating is the giving, taking, or presenting of information or material by a student that unethically or fraudulently aids oneself or another person on any work which is to be considered in the determination of a grade or the completion of academic requirements or the enhancement of that student's record or academic career. Cheating includes, but is not limited, to the following actions:

(a) Copying from someone else's assignment, examination, or other academic exercise;

(b) Possessing, buying, selling, removing, receiving, or using, at any time or in any manner not prescribed by the faculty member, any information related to an instrument of academic evaluation;

(c) Using materials, equipment, or assistance in connection with an assignment, examination, or other academic exercise which have not been authorized by the faculty member, including but not limited to, notes, calculator, or other technology;

(d) Obtaining or attempting to obtain, in a dishonest manner, any material relating to a student's academic work;

(e) Working with another or others in completing an assignment, examination, or other academic exercise when the faculty member has required independent and unaided action;

(f) Attempting to influence or change an academic evaluation, grade, or record by unfair means;

(g) Permitting another individual to substitute for one's self in an academic evaluation;

(h) Marking or submitting an examination or evaluation material in a manner designed to deceive the grading system;

(i) Failing to comply with a specific condition of academic integrity which has been clearly announced in a particular course;

(j) Submitting, without prior permission of the faculty member, any work by a student which has at any time been submitted in identical or similar form by that student in fulfillment of any other academic requirement at any institution;

(k) Submitting of material in whole or part for academic evaluation that has been prepared by another individual(s);

(l) Submitting data which have been altered or contrived in such a way as to be deliberately misleading; or

(m) Providing false information to the University in any manner to achieve an unfair advantage, enhance one's record, or complete a requirement.

Students with Disabilities:

"Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Resource Office at Holmes Hall, Suite 304, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with

students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (REG02.20.01)"

N.C. State University Polices, Regulations, and Rules (PRR):

"Students are responsible for reviewing the PRRs which pertain to their course rights and responsibilities. These include: http://policies.ncsu.edu/policy/pol-04-25-05 (Equal Opportunity and Non-Discrimination Policy Statement), http://oied.ncsu.edu/oied/policies.php (Office for Institutional Equity and Diversity), http://policies.ncsu.edu/policy/pol-11- 35-01 (Code of Student Conduct), and http://policies.ncsu.edu/regulation/reg-02-50-03 (Grades and Grade Point Average)."