

This course will be offered **online**  
Classes will take place through Webex (invitations will be sent out weekly) and the lecture notes with voiceovers will be made available through elearning

**The University of Texas at Dallas**  
**EEDG 7V81 High-Level Synthesis for VLSI 2020/2021**  
**Course Syllabus**



Time & Venue:

Lectures	Tuesday & Thursday	5:30pm – 6:45pm	Online
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Instructor:	Benjamin Carrion Schaefer
Email:	schaferb@utdallas.edu
Office:	ECSN 4.510
Telephone:	972-883-4531
Website:	www.utdallas.edu/~schaferb
Consultation hours:	By email
Teaching Assistant:	TBD

**Teaching and Learning Materials:**

Lecture notes and other teaching and learning materials can be downloaded from **eLearning** (<https://elearning.utdallas.edu/>). Announcements on teaching and course administration issues will be posted online.

**Textbook:**

[T1] Lecture notes

**References:**

[R1] High-Level Synthesis Blue Book, Michael Fingeroff. Xlibris Corporation.

[R2] SystemC from Ground UP, David Black and Jack Donovan

[R3] CyberWorkBench technical reference manual, NEC

[R4] Vivado HLx technical reference manual, Xilinx

**Prerequisites**

- C or C++ programming.
- Fundamentals of digital logic design (i.e. logic gates, timing, critical path)
- Verilog or VHDL.

## Course Objectives

The main objective of this course is to learn how to develop VLSI circuits using only high-level languages such as C/C++ or SystemC instead of low-level hardware description languages such as Verilog or VHDL. In addition, in this course you will be able to understand how complex VLSI work. In particular, heterogeneous Systems-on-Chip (SoC) composed of embedded microprocessors and dedicated hardware accelerators, all interconnected through different bus structures.

After the course, you should be able to understand the main components in complex SoCs and design dedicated hardware accelerators using C and SystemC as input languages instead of using low-level Verilog/VHDL code. In particular

- Review of VLSI design flow
  - Logic Synthesis
- Understand the process of High-Level Synthesis (HLS) and how it is able to convert untimed behavioral descriptions (e.g. C or C++) into efficient RTL code (Verilog or VHDL) that can execute it
- System-on Chip architecture
  - Embedded processors architectures (ARM, MIPS etc...). Soft processors (NIOS II, MicroBlaze)
  - SoCs bus structures (ARM AHB, AXI buses), Networks on Chip (NoC), etc...
  - Heterogeneous architectures using dedicated hardware accelerators
- Application Specific Integrated Circuits (ASICs)
- Field Programmable Gate Arrays (FPGAs)
- Input languages for HLS: C for Hardware design and SystemC.
- Commercial HLS tools:
  - ASIC :NEC's CyberWorkBench
  - FPGA: Xilinx's Vivado HLx
- Designing and verifying with HLS
- Build a complete heterogenous SoC using only C

## Assessments:

Continuous assessment (50%)

- Homework 50%
- 2 individual projects: 50% (25% each)

**The course will have no exams.**

**Project:**

Two individual projects will be assigned, involving an architectural simulation tool-set and programming in C and will be graded by the Teaching Assistant. Details about the projects will be provided as the semester progresses.

**Solution Availability:**

Solutions to homework/quizzes/projects will NOT be distributed. You can direct questions to the Teaching Assistant or subject lecturer.

**Course Modality and Expectations**

<b>Instructional Mode</b>	This course will be offered remotely (same time and date as regular class, but remotely). The video of the lecture will be made available shortly after the lecture so that every student can have access to the lecture asynchronously. Narrated PowerPoint slides will also be made accessible to students before each lecture through elearning. Tests and quizzes will also be administered online through elearning and students will be allowed to complete these over extended period of time to take into account time zone differences. For more information about the different teaching modalities: <a href="https://www.utdallas.edu/fall-2020/fall-2020-registration-information/">:https://www.utdallas.edu/fall-2020/fall-2020-registration-information/</a>
<b>Course Platform</b>	Slides and material will be hosted through elearning. The online lecture will be held through webex. An invitation to the online lecture will be made available to the student through individual announcements in the elearning portal.
<b>Expectations</b>	Students are expected to complete the work independently and to participate in class.
<b>Asynchronous Learning Guidelines</b>	Please check the following link for more information about asynchronous learning guidelines at UT Dallas: <a href="https://www.utdallas.edu/fall-2020/asynchronous-access-for-fall-2020/">https://www.utdallas.edu/fall-2020/asynchronous-access-for-fall-2020/</a>

**COVID-19 Guidelines and Resources**

The information contained in the following link lists the University's COVID-19 resources for students and instructors of record. Please see <http://go.utdallas.edu/syllabus-policies>.

**Collaboration Policy:**

You are encouraged to talk to your classmates about the homework problem sets. However, the write-up *must be your own*. Similarly, your project team is encouraged to discuss the project assignment with other teams. However, the report must be written by each team *on its own*.

**Re-grading Policy:**

Sometimes you may disagree with the grades you receive. Since *to err is human*, it is possible that mistakes may occur during grading despite our efforts to prevent this. You may appeal the grade you receive in an examination, within ONE WEEK from the day it is made available to you. To request a homework or project re-grade contact the teaching assistant. To request an examination re-grade contact the instructor. After this one-week period grades will be assumed correct and final.

**Getting Help:**

The best way to help yourself with this course is to attend lectures.

There are several more ways to get help, preferably in the following order:

- a) E-mail the Teaching Assistant or the instructor.
- c) E-mail the instructor.

*PLEASE include **EEDG 7V81 High-Level Synthesis** in the subject line of all e-mail correspondence.*

**Feedback:**

If you have any concerns regarding the course, please inform the instructor early during the term so that a prompt effort to resolve them can be made. Comments and feedback are also solicited as early as possible. Finally, please do not hesitate to stop the instructor in class and ask questions or post them on Blackboard. Remember that if you have some question others may do too and will benefit from your input.

## Lecture Schedule

### Time

5:30pm – 6:45pm, Monday and Wednesday

### Venue

Online

Week	Activities	Topics	Reading Material
1	Lecture 1	Introduction to SoC VLSI design	hlsvlsi-intro.ppt
2	Lecture 2	Embedded Processors	hlsvlsi-uP.ppt
3	Lecture 3	Logic synthesis	hlsvlsi-LS.ppt
4	Lecture 4	High-Level Synthesis	hlsvlsi -HLS.ppt
5	Lecture 5	CyberWorkBench	hlsvlsi-CWB.ppt
6	Lecture 6	ANSI-C for HW	hlsvlsi -BDL.ppt
7	Lecture 7	CyberWorkBench HLS tool	hlsvlsi-CWB.ppt
8	Lecture 8	ANSI-C for HW design	hlsvlsi-BDL.ppt
9	Lecture 9	HLS optimizations	hlsvlsi -HLS_opt.ppt
10	Lecture 13	Vivado HLS HLS tool	hlsvlsi -vivado.ppt
11	Lecture 10	Debugging and verification	hlsvlsi-debugging.ppt
12	Lecture 11	SystemC	hlsvlsi -SystemC.ppt
13	Lecture 11	Behavioral IPs	hlsvlsi -BIP.ppt
14	Lecture 12	SoC buses	hlsvlsi -buses.ppt
14	Lecture 14	Review	hlsvlsi -review.ppt

## **UT Dallas Syllabus Policies and Procedures**

The information below constitutes the University's policies and procedures segment of course syllabi, as described in <http://go.utdallas.edu/syllabus-policies>

### **Technical Support:**

If you experience any problems with your UT Dallas account, you may email [assist@utdallas.edu](mailto:assist@utdallas.edu) or call the UT Dallas Computer Help Desk at 972-883-2911.

### **Academic Support Resources**

The information contained in the following link lists the University's academic support resources for all students.

Please see <http://go.utdallas.edu/academic-support-resources>.

### **Student Conduct and 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 UT Dallas printed publication, *A to Z Guide*, which is available 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, Series 50000*, Board of Regents, The University of Texas System, 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) and online at <http://www.utdallas.edu/judicialaffairs/UTDJudicialAffairs-HOPV.html>.

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.

Students are expected to be attentive during class and to participate actively in group activities. Students are expected to listen respectfully to faculty and to other students who are speaking. Racism, sexism, homophobia, classism, ageism, and other forms of bigotry are inappropriate to express in class. Classes may discuss issues that require sensitivity and maturity. Disruptive students will be asked to leave and may be subject to disciplinary action.

**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:* Any student who commits an act of scholastic dishonesty is subject to discipline. Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, submitting for credit any work or materials that are attributable in whole or in part to another person, taking an examination for another person, or any act designed to give unfair advantage to a student or the attempt to commit such acts.

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.

**Comet Creed**

*This creed was voted on by the UT Dallas student body in 2014. It is a standard that Comets choose to live by and encourage others to do the same:*

“As a Comet, I pledge honesty, integrity, and service in all that I do.”

**Copyright Notice:**

The copyright law of the United States (*Title 17, United States Code*) governs the making of photocopies or other reproductions of copyrighted materials, including music and software. Copying, displaying, reproducing, or distributing copyrighted works may infringe upon the copyright owner's rights and such infringement is subject to appropriate disciplinary action as well as criminal penalties provided by federal law. Usage of such material is only appropriate when that usage constitutes “fair use” under the Copyright Act. As a UT Dallas student, you are required to follow the institution's copyright policy (UTDPP1043). For more information about the fair use exemption, see <http://copyright.lib.utexas.edu/copypol2.html>.

**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 UT Dallas email address and that faculty and staff consider email from students official only if it originates from a UT Dallas student account. This allows the university to maintain a high degree of confidence in the identity of all individuals corresponding and the security of the transmitted information. UT Dallas 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 UT Dallas provides a method for students to have their UT Dallas mail forwarded to other accounts.

**Withdrawal from Class:**

The administration of this institution has set deadlines for withdrawal from any college-level courses. These dates and times are published in that semester's course inventory and in the academic calendar. Administration procedures must be followed. It is the student's responsibility to handle withdrawal requirements from any class. In other words, a professor or other instructor 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.

**Student Grievance Procedures:**

Procedures for student grievances are found in university policy UTDSP5005 (<http://policy.utdallas.edu/utdsp5005>). 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 originated.

**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.

**Disability Service:**

It is the policy and practice of The University of Texas at Dallas to make reasonable accommodations for students with properly documented disabilities. However, written notification from the Office of Student AccessAbility (OSA) is required. If you are eligible to receive an accommodation and would like to request it for a course, please discuss it with an OSA staff member and allow at least one week's advanced notice. Students who have questions about receiving accommodations, or those who have, or think they may have, a disability (mobility, sensory, health, psychological, learning, etc.) are invited to contact the Office of Student AccessAbility for a confidential discussion.

The primary functions of the Office of Student AccessAbility are to provide:

1. academic accommodations for students with a documented permanent physical, mental or sensory disability
2. non-academic accommodations
3. resource and referral information and advocacy support as necessary and appropriate.

OSA is located in the Student Services Building, suite 3.200. They can be reached by phone at (972) 883-2098, or by email at [disabilityservice@utdallas.edu](mailto:disabilityservice@utdallas.edu).

**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.

## **Avoiding Plagiarism:**

[Adapted from Duke University's guidelines for writers; added July 2010]

*Take time to make careful choices among--and learn to use--the research tools* available to you. You will probably find that your favorite web search engine is not adequate by itself for college-level research. Consult with your professor or a librarian. You may need to use specialized research tools, some of which may require learning new searching techniques.

*Expect to make trips to the library.* While you can access many of the library's resources from your home computer, you may find that you need to make several trips to use materials or research tools that are not accessible remotely. Of course, you will be seeking the best information, not settling for sources simply because they happen to be available online.

*Allow time for gathering materials* that are not available at UT Dallas. The InterLibrary Loan Office can borrow articles and books from other libraries, but this process takes additional time.

*Allow time for reading,* rereading, absorbing information, taking notes, synthesizing, and revising your research strategy or conducting additional research as new questions arise.

*Sloppy note-taking increases the risk that you will unintentionally plagiarize.* Unless you have taken note carefully, it may be hard to tell whether you copied certain passages exactly, paraphrased them, or wrote them yourself. This is especially problematic when using electronic source materials, since they can so easily be copied and pasted into your own document.

*Identify words that you copy directly* from a source by placing quotation marks around them, typing them in a different color, or highlighting them. (Do this immediately as you are making your notes. Don't expect to remember days or weeks later what phrases you copied directly.) Make sure to indicate the exact beginning and end of the quoted passage. Copy the wording, punctuation and spelling exactly as it appears in the original.

*Jot down the page number and author or title* of the source each time you make a note, even if you are not quoting directly but are only paraphrasing.

*Keep a working bibliography* of your sources so that you can go back to them easily when it's time to double-check the accuracy of your notes. If you do this faithfully during the note-taking phase, you will have no trouble completing the "works cited" section of your paper later on.

*Keep a research log.* As you search databases and consult reference books, keep track of what search terms and databases you used and the call numbers and URLs of information sources. This will help if you need to refine your research strategy, locate a source a second time, or show your professor what works you consulted in the process of completing the project.

*You must cite direct quotes.*

*You must cite paraphrases.* Paraphrasing is rewriting a passage or block of text in your own words. If you paraphrase, you must still cite the original source of the idea.

*You must cite ideas* given to you in a conversation, in correspondence, or over email.

*You must cite sayings or quotations that are not familiar, or facts that are not "common knowledge."*

However, it is not necessary to cite a source if you are repeating a well known quote or familiar proverb. Common knowledge is something that is widely known. For example, it is widely known that Bill Clinton served two terms as president; it would not be necessary to cite a source for this fact.

*These types of sources should be cited as well. Printed sources:* Books, parts of books, magazine or journal articles, newspaper articles, letters, diaries, public or private documents; *Electronic sources:* Web pages, articles from e-journals, newsgroup postings, graphics, email messages, software, databases; *Images:* Works of art, illustrations, cartoons, tables, charts, graphs; *Recorded or spoken material:* Course lectures, films, videos, TV or radio broadcasts, interviews, public speeches, conversations.

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