COURSE SYLLABUS

1 ECE 8455 - Advanced Digital Design Using FPGAs

2 Meeting Information

3 credits, 3 contact hours

a. **Section All:**
Lecture: Wednesday from 12:00 pm to 02:30 pm, **in CEER 314**

3 Course Instructor(s), TA(s)

a. **Section All:**

Class Instructor:	Xiaofang Maggie Wang
Office Hours:	TR 11:50 AM - 12:50 PM, or by appt.
TA:	None

4 Textbook

This course does not have a prescribed textbook

a. **Other Supplemental Materials:** There is no particular textbook required as I will be integrating materials from many sources. However, a comprehensive VHDL reference book is required. If you do not have one, the following book is recommended.

A VHDL Primer, 3rd edition, J. Bhasker, Prentice Hall, 1999, ISBN: 0-13-096575-8.

b. **References:**
1. Advanced FPGA Design: Architecture, Implementation, and Optimization, by S. Kilts
2. Technical documentation in the course References folder

5 Specific Course Information

a. **Catalog Description**
Introduces students to advanced digital design and implementation using FPGAs (Field-Programmable Gate Arrays). Topics include VHDL & Verilog, FPGA architectures, programming technologies, design methodologies, simulation and synthesis, place and route, and timing analysis, which board and EDA tools are used to help students gain hands-on experience. Prerequisite: Digital/logic design and VHDL basics.

b. **Prerequisites:** Digital logic design and VHDL basics (VU ECE 2042 & ECE 2043 or equivalent courses).; **Co-requisites:** None

c.

6 Course-specific Goals

a. An FPGA (Field-Programmable Gate Array) device is a semi-custom integrated circuit (IC) that contains an array of programmable (configurable) logic blocks and programmable (configurable) interconnects that connect the logic blocks. FPGAs have undergone phenomenal

advances in capacity and complexity during the past few years, and have transformed into most flexible and domain-specific platforms for many applications. Such advances, along with the skyrocketing costs of nano silicon processes and the ever-shrinking time-in-market window continue to successfully help FPGAs erode ASIC and ASSP market shares. The objective of this course is to introduce students to advanced digital design using VHDL/Verilog for FPGAs. We start with fundamental concepts of FPGAs and focus on practical aspects of FPGA-based digital design later on. Students will learn various FPGA design approaches, such as HDL-, schematic-, and C/DSP-based methods. The final segment of the class covers special topics that identify current trends in FPGA technologies. The design and implementation tools used throughout the course include Quartus Prime and ModelSim. Hands-on experience is gained by implementing various designs and a comprehensive project on an Intel (Altera) FPGA development board. Please check the course schedule of topics for more details.

7 List of Covered Topics

1. **Please refer to the schedule of topics below.**

8 Tentative Schedule

Tentative schedules for all sections follow. Be sure to refer to the schedule for your specific section, if more than one is provided.

Tentative Schedule for **All Sections**

Date	Topics
08/25	Course Overview; Introduction to FPGAs
09/01	FPGA design methodology and tools; Quartus Prime Tutorial 1
09/08	VHDL 1: Hardware modeling basics; Tutorial: Basic ModelSim simulation
09/15	Introduction to Verilog
09/22	VHDL 2: Behavior modeling
09/29	VHDL 3: FSM and advanced topics
10/06	Testbench; Design Examples: Audio codec Tutorial: Advanced ModelSim simulation
10/13	Fall Break
10/20	Midterm exam
10/27	Memory designs for FPGA-based systems
11/03	Lab and project help
11/10	VHDL/Verilog codling style for synthesis optimizations
11/17	Optimizing performance by driving FPGA synthesis tools
12/01	FPGA power analysis, reset and clock circuits, and timing issues
12/08	Project Presentation

9 Grading Policy

1. Homework Assignments – 50%
2. Final exam – 25%
3. Project: 25%

Letter grade scale: A(94–100), A–(90–93), B+(87–89), B(83–86), B–(78–82), C+(74–77), C(70–73), F(<70)

10 HW Assignment and Laboratory Report Submission Policy

Weekly homework assignments will be posted in the Blackboard and due the following week, unless announced otherwise.

Learning how to look for appropriate technical documentation, read and understand them efficiently in a focused manner is one of the essential engineering skills, and one of the objectives of the course. You are expected to develop debug skills through vendor's technical documentation and discussion forums when you have questions and problems with the assignments and project. In addition to the lectures, additional reading assignments will be posted on the course web as needed.

11 Attendance Policy

You are expected to attend all the class meetings and are responsible for all the material covered in class including handouts and class notes.

Whenever possible, students should inform the instructor if they plan to be late or absent from class. In all cases, documentation is required to petition for *excused* absences to the Associate Dean for Student and Strategic Programs, Dr. Stephen Jones. The excused absence form is posted at: https://www1.villanova.edu/villanova/engineering/resources/undergraduates.html.

Excused absences do not count towards a failure in the course for first year students. Absence from class does not release the student from assigned work. Students who miss an in-class obligation such as an exam, a presentation, etc., due to an excused absence will not be penalized - the instructor may offer a make-up test, arrange an alternative time for a presentation, exempt a student from the assignment, or provide another arrangement. In the case of illness or injury, the form must be submitted within 24 hours of missing a class. The University's list of excused absences for all students includes the following:

1. Participation in NCAA athletic competitions
2. Participation in special academic events such as: conferences, field trips, project competitions, etc., and in official university business such as student representatives attending meetings related to university governance
3. Attendance at significant events of the immediate family such as: funerals, weddings, etc.
4. Religious holidays - see the University's policy on Religious Holidays
5. College-approved participation in placement activities such as: job interviews, graduate school interviews, job fairs
6. Legally required absence such as: jury duty, court appearance, short-term military service
7. Documented serious illness or disability

12 Examination Policy

The College of Engineering has adopted the following general examination guidelines:

1. Students must arrive before the start of the examination. Under exceptional circumstances a student may need to arrive late, but he/she can enter the examination room no later than five (5) minutes after the start of the exam.
2. Cell phones must be turned off until the student exits the examination room.
3. The official Villanova class attendance policy must be followed when requesting excuses for absences or lateness to an examination.
4. Each student must write and sign the following statement, "I have neither given nor received any unauthorized assistance in the completion of this examination."
5. For online examinations, the instructor may implement video proctoring or other measures to ensure academic integrity. For consent purposes, the instructor will inform students in advance if (s)he plans to use any form of video-proctoring and whether the examination will be recorded.

13 Academic Integrity Policy

The College of Engineering is committed to creating an environment of academic integrity and ethical decision-making that we hope is reflected in the actions of our students and graduates. As Villanova students, integrity is central to the University mission. As engineers, our code of conduct requires us to place honor and integrity at the forefront of everything we do. As engineering students, it is expected that you will begin to adopt these values and instill them into your work habits. Students violating the academic integrity policy will receive a zero on that assignment or exam and the violation will be reported to the Associate Dean for Academic Affairs. The University's academic integrity policy can be found on the following web page:
https://www1.villanova.edu/villanova/provost/resources/student/policies/integrity.html.

14 Adherence to the Student Code of Conduct

Students are expected to act in a professional and respectful manner to their fellow students, faculty, and staff. Students should become acquainted with and understand the responsibilities set forth in the Student Handbook, especially those in the sections on Policy and Regulations. Adherence to university regulations is expected and required for successful completion of the program of studies. Enforcement within the classroom of policies regarding classroom behavior is the responsibility of the faculty member. All other discipline problems are to be referred to the Dean of Students.

15 Online Expectations

To foster a professional environment, please wear appropriate clothes, mute if you are not talking to cut down on background noise, refrain from eating, and select an appropriate setting when we are meeting online.

16 Inclusive Classroom

This classroom is a place where you will be treated with respect; we welcome individuals of all ages, backgrounds, beliefs, ethnicities, gender, gender identities and expressions, sexual orientation, and other visible and non-visible differences. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment to allow all among us to learn and flourish.

17 Students with Disabilities

It is the policy of the university to make reasonable academic accommodations for qualified individuals with disabilities. If you are a person with a disability (non-physical) please register with the office of Learning Support Services (LSS) by emailing Learning.support.services@villanova.edu or by phoning 610-519-5176 as soon as possible. Registration is *required* in order to receive accommodations.

The Office of Disability Services (ODS) collaborates with students, faculty, staff, and community members to create diverse learning environments that are usable, equitable, inclusive and sustainable. The ODS provides Villanova University students with physical disabilities the necessary support to successfully complete their education and participate in activities available to all students. If you have a diagnosed disability and plan to utilize academic accommodations, please contact and register with Gregory Hannah, advisor to students with disabilities at 610-519-3209 or visit the office on the second floor of the Connelly Center.

18 Tutoring Services

Villanova's tutoring services include The Writing Center, The Learner's Studio, and The Center for Speaking and Presentation. These services are offered free of charge to students. Drop in as-needed or book a regular weekly session to supercharge your academic success. Sessions can be 30 or 60 minutes in length.

Register for an account and book sessions in advance at villanova.mywconline.com. If you don't see your class listed, request a tutor for a missing subject at: tutorrequest.villanova.edu For more information, contact Juliana Struder at juliana.studer@villanova.edu or at 610-519-5862.

19 Electronics Policy

The use of electronic devices, such as phones, laptops, tablets, calculators, etc., during class is generally allowed, unless their use causes a disturbance to others. During examinations, the use of any electronic device is prohibited, unless it is expressly authorized by the instructor.

Students are prohibited from making any audio or visual recordings (including taking photographs) of lectures, discussions, or other classroom activities, unless a student (1) has written permission in advance from the instructor, or (2) is permitted to record under terms and conditions as approved by the University's Office of Disability Services or Learning Support Services. Students who have received approval to record classes as an academic accommodation must provide supporting documentation from the Office of Disability Services or Learning Support Services in advance of any recording. Students may use authorized recordings only for the purposes of individual study in the course, and may not disseminate or share them with a wider audience without explicit permission.

20 Copyright Policy

The materials used in Villanova University courses ("Course Materials") generally represent the intellectual property of course instructors, third parties and/or the university which may not be disseminated or reproduced in any form for public distribution (e.g., sale, exchange, etc.) without the written permission of the course instructor. Course materials include all written or electronic documents and materials, including syllabi, current and past examination questions/answers, and presentations such as lectures, videos, slides, etc., provided by a course instructor. Course materials may only be used by students enrolled in the course for academic (course-related) purposes.

Published course readings (book chapters, articles, reports, etc.) available in "Blackboard" are copyrighted materials. These works are made available to students through licensed databases or fair use. They are protected by copyright law, and may not be further disseminated or reproduced in any form for distribution (e.g. uploading to websites, sale, exchange, etc.) without the permission of the copyright owner.

Follow these links for more information on Intellectual Property, Copyright, and Computer Acceptable Use.

21 Professorial Duties

It is important to note that teaching is one of the many duties that professors perform as part of their job responsibilities. In addition to teaching, professors perform research, advise graduate students, edit journals and review journal articles, serve on committees for the university and professional societies, travel to conferences to remain abreast of current developments and to present their results... to name just a few commitments.