Incorporating EDA into the Rowan ECE Curriculum

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Abstract

This paper describes the Electronic Design Automation (EDA) environment at Rowan University’s College of Engineering. The courses are summarized and an evaluation of the environment is presented.

1. Introduction

The College of Engineering at Rowan University is a predominantly undergraduate teaching college with a small Masters’ program. Approximately 120 students are accepted each fall into the College, typically 35 to 40 of them declare a major in Electrical and Computer Engineering (ECE). We have developed a unique program that emphasizes design and entrepreneurship throughout the curriculum but especially in our eight semesters of Engineering Clinic [1].

The Electronic Design Automation (EDA) environment at Rowan University is an integral part of the ECE curriculum. Each student is given the opportunity to learn and master many different aspects of EDA during their engineering education.

At Rowan University we participate in the Mentor Graphics Higher Education Program. At present we focus on the Integrated Circuit (IC) Design and Layout tools that are available through Mentor Graphics to meet our educational goals. This gives us a wide variety of options throughout the curriculum for incorporating EDA tools into the courses and allows the students an opportunity to develop proficiency before graduation.

We operate the EDA tools on two different platforms. Our basic platform for schematic driven layout (SDL) is the UNIX environment. We have a laboratory equipped with 25 Sparc Ultra 10 workstations where the majority of our course work is accomplished. The students also use an X-Windows emulator to access the software from remote laboratories. In addition, we have recently installed Mentor Graphics’ FPGAdvantage for HDL-based design on an NT platform.

In the following sections of this paper, I will describe both how and where we use the EDA tools in the ECE curriculum. I will conclude with an assessment of the EDA experience at Rowan University.

2. Courses Incorporating EDA

2.1 Networks I

The first major course that the ECE majors take is Networks I. This is the traditional circuits course that is offered at the beginning of an EE curriculum. Normally, of course, we would not teach IC Design at this level of the curriculum and, in fact, we don’t. But we do take the opportunity to allow the second year students to become familiar with the Mentor Graphics interface by having them use two of the available tools. First the students work with Design Architect. This tool allows the students to create schematics for the circuits that they are learning to analyze. Once they have created the schematics, Accusim, Mentor Graphics analog simulation tool is used to provide output for specified input conditions. Using these tools is comparable to using a program such as PSpice to perform simple circuit simulations and the students sometimes ask me if there isn’t an easier way to accomplish our goal than using the Mentor Graphics tools. The answer, of course, is yes but by forcing the students to become familiar with both Design Architect and Accusim, the learning curve in our junior level VLSI Design class flattens significantly. For this application of the Mentor Graphics EDA tools, we make use of the generic libraries that are included with the tools.

2.2 Electronics I & Sophomore Clinic

As the students continue their basic courses, we continue to use the Mentor Graphics tools for circuit design and synthesis. The two courses where the students obtain the most experience with the tools are 1) the introductory electronics course, and 2) our laboratory-based introductory design course, Sophomore Clinic. Electronics I is a (somewhat) traditional EE course but includes a MacroElectronics component where the students are required to design, simulate, and construct a device such as a power supply, function generator, or curve tracer. Sophomore Clinic is a very unique experience for our students; each spring semester all sophomores work in multidisciplinary teams to design, build and test a product [2]. This product is always electro-
mechanical in nature and requires circuit design, simulation and construction (from discrete components). In both of these courses students make extensive use of the Mentor Graphics tools that they have learned to use in their Networks I class. By the end of the sophomore year both the ECE students and the Mechanical Engineering students have acquired circuit simulation skills and a familiarity with the Mentor Graphics EDA environment.

It is worth mentioning here that the integration of the EDA tools into these sophomore courses has been successful because of the cooperation that I have received from my colleagues. I prepare step-by-step tutorials for the students and hold informal learning sessions for the faculty to smooth the introduction.

2.3 Electronics II – VLSI Design

It is in the junior year that the first VLSI Design course is taught. This is the fourth year that I have taught the course using the Mentor Graphics tools and it is still evolving! In its most recent form I have created the following broad divisions:

- Introduction to device physics
- MOSFET models
- Fundamental CMOS circuit configurations and layout
- Sequential and Combination Logic circuits and Memory

This is an ambitious agenda but it has worked. In early laboratory sessions the students investigate the fundamentals of CMOS technology and simple digital circuits. The course has now matured to the point that there are standard projects developed each year that is modified and improved to reflect the growing capabilities that I incorporate into the EDA environment.

During our first two years the projects were simple logic gates with a final design project, the Digital Phase Locked Loop. This pattern has been modified by work that I have done with two of my colleagues, Drs. Ramachandran and Mandayam on an NSF funded CCLI project titled, Communications, Signal Processing and VLSI: Education Under a Common Framework [3]. As a result of the collaborative effort that we have done to integrate the second semester curriculum for the junior level students, the VLSI Design projects have tended to emphasize DSP and Communications applications. For instance, a laboratory assignment was developed to implement the Hamming Encoder/Decoder algorithm. Since this implementation is based on logic sub-circuits it is a natural follow-on for the work that the students have done in the beginning of the semester. The second project that we have implemented is Digital to Analog conversion. Throughout the semester, these VLSI design projects are coordinated with theory content in the other classes that the students are taking. Besides providing challenging IC design projects, this effort has given the students more insight into the inter-relatedness of the coursework that they are pursuing.

This semester we will be emphasizing analog CMOS circuit design in the Electronics II course and consequently our design and layout projects will be retooled to meet this objective.

2.4 Senior Electives / Graduate Courses

To date I have co-taught two senior elective / graduate courses that have taken advantage of the EDA environment, 1) VLSI Architectures for DSP Applications and 2) VLSI for Wireless Communications. In each of these courses a small group of students with interest in both VLSI Design and the application area combined lecture and laboratory experience to enhance their background in both theory and circuit design. The analog design environment that the students experienced in VLSI for Wireless Communication was especially challenging and the difficulties that we experienced were one of the driving forces for revising the junior level course.

We currently have one graduate student who is completing a thesis working with the Mentor Graphics tools. His topic is a VLSI implementation of an algorithm to compute Line Spectral Frequencies.

3. Assessment

After four years I feel that we have made very significant progress in establishing the necessary tools and background instruction to claim a strong EDA component in the ECE curriculum at Rowan University. The most effective decisions have been 1) to institute familiarity with the tool interface at the sophomore level and 2) to collaborate with other faculty members on team-taught courses in the senior elective / graduate courses. I am looking forward to teaching the newest version of Electronics II as an analog design course this coming spring.

References

