Distance Learning Courses on Campus

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Abstract

This paper describes the development of a distance learning course in Semiconductor Processing and the use of the course for an on campus offering. The objective was to spread the development cost over more courses and students by offering the same course on campus. Results and lessons learned will be presented.

Introduction

The development and use of distance learning programs for engineering programs, particularly masters degree programs, has been around for many years. Most of the programs, until recently have used live or taped video presentations with occasional audio questions and answers. Currently, new distance education programs using the Internet are becoming available. The development of these programs can be very time consuming and costly. Unless there is a large, continuous demand for these distance courses it is difficult to justify the development cost. Another concern that always arises when considering distance education is the relationship of the distance course to an on campus course. Maintaining the same quality of instruction for the distance courses compared to campus courses can be difficult in some cases.

One possible approach to solving these problems is to use the same materials for both the distance education course and the on campus course. This allows the development cost to be spread over more courses and students. It also can help to insure the courses are basically the same. However, other important questions arise. Is a distance learning formatted course effective for an on campus offering? Do the instructors that developed the course obtain some credit for future offerings? Is this approach cost effective?

An Example Program

In the Fall of 1996, a combined senior/graduate course on semiconductor processing was offered by the Electrical Engineering Department at Texas Tech University. Although this course was offered on campus, it was developed for distance learning. The objective was to try to determine if a course structured for distance learning could be taught effectively on campus. The course had an enrollment of 18 undergraduates and 12 graduate students. The course overview, as it appeared on the web site is shown below.

Course Overview

EE 5381

INTRODUCTION TO VERY LARGE SCALE INTEGRATED CIRCUIT PROCESSING

Course Text

***Silicon Processing, Vol. I* by Wolf and Tauber**

Goals of the Course

EE 5381 is designed to introduce engineering graduate students to the principles, systems and techniques used in semiconductor integrated circuit processing.

Course Prerequisites

Math, physics and chemistry equivalent to that covered in a Bachelor of Science in Engineering degree. This course is open to graduate students in other engineering, math and science areas with an equivalent background.

Course Structure

The course will be structured into 11 separate lessons. Each of these lessons will include all or most of the following techniques:

- Study Guide
- Video
- Notes (on web)
- Textbook
- Web site resources
- Assignments - Questions, Problems, and Projects
- News page - with recent updates
- Question and answer page - with recent updates

Also, computer simulation programs will be used for many components of the course.

Lesson Modules

*LESSON	*TOPIC	*EQUIVALENT LECTURE
*1	***INTRODUCTION** Properties of Silicon Overview of VLSI Processing	*4 hours
*2	***OXIDATION** Properties of Silicon Dioxide Kinetics of Oxidation The Oxidation Process	*4 hours
*3	***DEPOSITION** Properties of Thin Films Deposition Techniques	*3 hours
*4	***ETCHING** Chemical Etching	*2 hours
*5	***PLASMAS** Introduction to Plasmas Plasma Etching Plasma Enhanced Deposition	*4 hours
*6	***DIFFUSION** Diffusion Equations Characterization Diffusion Process	*4 hours
*7	***IMPLANTATION** Implant Characteristics Defects Equipment	*3 hours
*8	***EPITAXY** Molecular Beam Epitaxy Characteristics Hardware	*2 hours
*9	***LITHOGRAPHY** Standard Photolithography New Techniques	*5 hours
*10	***METALLIZATION** Contacts Multilevel Metallization Process Techniques	*5 hours

*11	***YIELD** Measurement Tracking Analysis	*6 hours

In general, each lesson included an overview, a suggested approach to the lesson, a problem assignment and, in some cases, project assignments. The graduate students had additional problem assignments and different project assignments than the undergraduates. As an example, the outline for Lesson 1 is given below.

OVERVIEW OF LESSON I:

Lesson I concerns itself with a review an overview of silicon processing. Most of the processing techniques in this course will be limited to those involving silicon. Lesson I will provide a review of the properties of silicon, an overview of basic processing techniques, and an example of the steps involved in making a device.

READING MATERIALS FOR LESSON I

Textbook
Student Reports by Guo and Faruk.
Lesson I notes.
Web site www.ece.uiuc.edu/ece344/

SUGGESTED APPROACH FOR LESSON I

1. Watch the video for Lesson I (General video on IC Processing).
2. Read the student papers and review the properties of silicon.
3. Read the textbook Chapter 1 and Chapter 2 through p. 62.
4. Review the notes for Lesson I.
5. Visit the uiuc website. Click on the "process overview" hypertext and follow the 18-step process outlined there.
6. Work on the project for Lesson I.
7. Return to the original web page. A figure is shown of a wafer onto which an IC has been designed. Click on various areas to view an expanded drawing of the selected area. Clicking on any device in the expanded drawing will bring up a tutorial on that device. Use this figure to explore various devices that are grown using VLSI processing techniques.
8. Answer the questions for Lesson I.

The class met for one hour, one day a week, to view video tapes, to try to overcome any problems with the course and to foster student interaction and peer learning. The assignments were originally to be e-mailed in, but only a fraction of the students had e-mail accounts. In addition, sending attached files over e-mail produced numerous encoding and decoding problems. An ftp site was set up to provide for transferring assignments from the students. A Question and Answer page and a News page were set up on the web to try to promote increased participation and to let the students know if new material was available.

Results

The amount of time required for the summary lessons to be converted and put on the web was much greater than anticipated, and this created some delays in getting material to the students. Others[1] have reported using teaching assistants and student programmers to assist in the course. Unfortunately, this type of assistance was not available for this course.

The student submission of assignments by ftp worked adequately, after a few initial problems. However, the ftp approach did not work effectively for submission of questions. Going through 30 different sub directories to find new files containing questions was too time consuming. Also, communicating back to 30 students individually by ftp was much too time consuming and was abandoned. The Q&A and News pages on the Web helped to some degree. The one hour a week meeting did not seem to be enough time to foster peer learning. Some team projects were used , but getting the teams to interact seemed to be much harder in this environment than in standard courses. Others[1,2] have reported that using e-mail, chat rooms and other approaches help increase student interaction, but not to the level that can be obtained through more standard courses. Interestingly, the majority of the students invariably printed out all of the Web information instead of referencing it from their computers, which has also been reported elsewhere[2].

The assignments from the students were actually very good. They included more graphics and details than are normally seen on paper assignments. However, borrowing information from the Web is very easy and students had a tendency to forget that this is the same as using information from a book and must be referenced.
The final results of the course were satisfactory in that the students seemed to have learned the material required. However, not as much material was covered as had been covered previously in a standard course. Also, the majority of the students (60%) did not feel that they learned as much from the course as they did in standard courses. This was not be a surprise since informal, collaborative learning is well known to be an extremely effective learning mechanism[3-6]. At present, the interactive capabilities through the internet are not at the level of direct, face-to-face interaction. However, this is rapidly changing.

The amount of time and money spent developing the course is not the only cost

consideration. As reported elsewhere[1], the time spent administering the course can be a significant problem. In our case, though, we team taught the course, and the work load was easily equal to or greater than teaching a standard course alone.

The greatest advantage in using the Web is the amount of learning material that is available and easy to obtain. The Web is, in some ways, like a giant resource library. Unfortunately, it is more like thousands of small libraries, which makes it difficult to find some things and the resources tend to ebb and flow. There were a number of web sites that were very good references for our course that disappeared during the course. There seems to be an increasing trend to restrict many educational resources on the Web. Until copyright issues and ease of payment issues are resolved, this trend may significantly reduce the value of the Web.

Conclusions

To answer the two original questions:
Is a distance learning formatted course effective for an on campus offering?
The answer, for our case, is basically no. The additional material makes for a very good supplement for a more standard course, but trying to use a distance learning format for an on campus course does not appear to be a good approach.
Is this approach cost effective?
The answer, for our case, is, again, basically no. The development cost can not be easily distributed between off campus and on campus courses. The development is an additional expense that could be considered as improving the quality of the offering, but not as a cost saving measure. The administrative cost of running the course is also greater than a standard course. Again, this could be considered as an on-going expense to improve quality, but does not appear to be the cost saving tool that some people may invision.

In summary, tools for distance education, such as use of the internet, can be excellent supplements to existing classes, but do not, at this time, seem to be able to substitute for the real residence experience.

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