Digital System Design and Interfacing

Course Description

System hardware and software; Bus design and timing, processor and local buses, bridge and bus hierarchy, fault-tolerant; Parallel, serial, and Internet communication, RS232, USB, SATA, GPIB, PCI, SCSI; A/D and D/A; System design process, design entry, signal integrity, PCB testing

Prerequisites

EE120 with grade C or above, and:

- Master in building simple circuits from logic gates and/or fundamental building blocks.
- Master in microprocessor and microcomputer structure and operations.
- Familiarity with C or C++ and assembly programming languages.
- Familiarity with digital software design tools used in electrical and computer engineering areas such as ORCAD, CARDTOOLS, etc.

Course Topics

System Overview

CPU & Microprocessor
- RISC & CISC
- General Purpose Processors: Pentium, MIPS, PowerPC
- Embedded Processors: Micro-Controller, DSP Processors
- System on Chip (SOC): Network Processors

System Software
- OS
- BIOS

Component Interfacing

Bus Design
- Bus Components: Drivers, Arbiters
- Synchronous & Asynchronous Buses
- Endian
- Electrical Characteristics: Pull-Up & Down, Tri-State, Delay, etc.

Processor Bus
- Memory System Design, Timing, and Fault-Tolerant
- Memory Classification: RAM, ROM, SRAM, DRAM, Flash, FIFO, etc.

Local Bus
- PCI Bus Description and Bus Protocol
- DMA on Local Bus
- PCI Bridge and Bus Hierarchy
Learning Objectives

The course learning objectives are designed to mainly contribute to ABET2000 criteria 3a, 3b, 3c, 3e, 3f, 3g, 3i, 3k, and 3l of the EE program objectives. The contributions are satisfied by the completion of learning objectives listed below together with the course format described in the "Relationship to Program Objectives" section.

1. To be able to identify and outline several families of microcomputer and their peripherals.

2. To be able to identify and outline several popular techniques used to carry out data acquisition and digital system control.

3. To understand and be able to apply the theory and operation characteristics of microcomputer buses, bus structures and operations, standard bus specifications and design techniques, bus control and bus interfaces.

4. To understand and be able to apply the theory and operation characteristics of serial and parallel communication interfaces, standard communication specifications and design techniques, the control of communication interfaces and related peripherals.

5. To understand and be able to apply the interfacing techniques used in microcomputer systems and the use of personal computers to interface external devices such as digital timers, analog and digital I/O, display terminals, keyboards, etc.

6. To be able to identify and outline the characteristics and operation of D/A and A/D converters, the uses of A/D and D/A in building data acquisition circuits, the principle of data sampling, waveform digitization, and frequency aliasing.

7. To be able to use hardware design tools, program development software, and instruments to design, fabricate, debug, test, and evaluate the operation and performance of a microcontroller based system and its interfaces.

8. To be able to apply and practice the theory of programming control interfacing, such as developing assembly and C/C++ language programs for implementing mathematical, logical, timing, and interruption operations. These include interfacing wiring techniques, event timing, and handshaking operations and analysis.
9. To be able to report your experiments, analysis, design, etc. in comprehensive formal writing and oral presentation formats, where the technical content, the appearance, the presentation, etc. are all considered to be important.

10. To be able to work in a group, to share experience and knowledge, to keep-up individual responsibility and to communicate professionally and effectively with the group members

**Relationship to Program Objectives**

This course supports the achievement of the following program objectives as explained by specific ABET2000 criterion listed below:

3a *An ability to apply knowledge of mathematics, science, and engineering*
   The students will be able to:
   - Use mathematic, science, and engineering knowledge for the calculations needed in digital interfacing design such as communication bit rates, computer bus and processor timings, communication bandwidths, error correction and detection schemes, etc.

3b *An ability to design and conduct experiments, as well as to analyze and interpret data*
   The students will be able to:
   - Design prototype commercial device interfaces
   - Run existing test programs and test cases as specified by the experiment procedure
   - Gather the experimental results. Analysis and report the results

3c *An ability to design a system, component, or process to meet desired needs*
   The students will be able to:
   - Design and build interfacing circuits to accomplish the assigned tasks
   - Develop test programs and test cases to control and study the experimental circuits
   - Run the test cases, analysis and report the results
   - Discuss possible alternative designs to advance the current design

3e *An ability to identify, formulate, and solve engineering problems*
   The students will be able to:
   - Troubleshoot any faulty of the experimental circuits and identify the sources of the faults. Discuss the methods of solutions
   - Create several potential problems from the assigned interfacing circuits and prototype their behaviors. Identify the methods of solutions.

3f *An understanding of professional and ethical responsibility*
   The students will be able to:
   - Self-schedule and independently work on laboratory exercises and projects in open laboratory environment.
   - Work on experiments as groups for data collections and for discussions, but write their own individual analysis and design reports. The reports must be cited for referenced information from group discussions, technical papers, books, websites, etc.

3g *An ability to communicate effectively*
The students will be able to:
- Write their own individual analysis and design reports with references and biography.
- Orally present their design project at the end of the semester.

3i *A recognition of the need for, and an ability to engage in life-long learning*
The students will learn the trends and the developments of computer interfacing techniques over the years. The students will be able to:
- Discuss the problems and solutions for each lab exercise and design project
- Develop new ideas for future improvements and enhancements for each lab exercise and design project

3k *An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*
The students will be able to:
- Write the control programs with assembly and C/C++ programming languages to control the interfacing circuits and/or external devices
- Use commercial C/C++ compiler package such as Borland C/C++ or Microsoft Visual C/C++ for their programming interface
- Use hardware design tool such as ORCAD for the design assignments/projects
- Use traditional instruments such as digital multimeter, wave generator, oscilloscope, etc. to measure and to obtain experimental data

3l *One or more technical specialties that meet the needs of Silicon Valley companies*
- All of the technical specialties listed in "Learning Objectives" meet the needs of Silicon Valley companies

**In-class Assessment Methods**

- Class participation and learning attitude.
- One midterm exam and one final exam
- Six laboratory exercises and design project reports
- One oral project presentation.
- Semester-end course survey and instructor evaluation.

**Contribution of Course to Meeting Professional Component**

- Engineering Science: One unit
- Engineering Design: Two units

**Instructor:** Dr. Thuy T. Le

**Office Hrs:**
- MW: 17:00 - 18:50, ENGR369
- TTH: 08:20 – 09:00, ENGR369
- Friday: By appointment only

**Contact inf.:**
- Email: thuytle@email.sjsu.edu, Phone: (408) 924-5708
- Web: http://www.engr.sjsu.edu/tle
Note: If you need to communicate with me, please try to see me in person during the office hours. If you must send me an email, please clearly specify your full-name and course number. I will not respond to email that I do not know the author or emails that have no manners.

**Manual/Text:** "Digital Interfacing Lecture Notes" by Thuy T. Le  
"Digital Interfacing Laboratory Manual" by Thuy T. Le  
Maple Press – 481 E. San Carlos St. San Jose, CA 95112 (408) 297-1001  
(Corner of San Carlos and 10th Street)


**Meetings:** MW: 19:00 - 20:15, ENGR244 (Digital Interfacing Laboratory)

**Lectures**

The course will follow the topics as listed previously, but additional topics may be added if necessary and if time is permitted.

- Students are responsible for reading the text, lecture notes, and references in details.
- Students are responsible for following up the lecture materials.
- Students are responsible for reading additional information and examples in order to gain more knowledge about the materials discussed in the lectures.

**Laboratory Exercises and Design Project Assignments**

- Five laboratory exercises or design projects will be assigned during the semester and are due by the due dates. NO late submission will be accepted (absolutely!).
- All reports must be prepared neatly and professionally. The technical contents, format, completeness, and appearance of the report all contribute to the report's grade. Requests for rewriting the reports after they were graded are unacceptable.
- Student names on the reports must be your official names. Nicknames must not be used for the reports and exams.
- You are responsible to include all requested and necessary information in your reports.
- Your report must have sections in order as listed below and as requested from the laboratory manual. Each section must start with the new page.
  - A cover page which includes course number, instructor name, student name, semester, project/lab number, project title, and the due date.
  - An "Introduction" section to introduce the project/lab to the readers.
  - A "Summary and Conclusion" section to emphasize the most important results and information of the entire project/lab.
  - The main body of the report, which includes many sub-sections such as experiment setup, list of instruments and/or equipments, block and/or circuit diagrams, data output, graphs, program flowcharts, program sources, discussion, analysis, answers to additional questions, etc.
  - A "References" section to list all references. Reference numbers must be cited in the text with square brackets such as [#].
  - An "Appendices" section to attach any documents, copies, etc. that support your report.
Please note that each section must start on the new page. Figures and tables must be labeled separately and clearly. Reports must be condensed but completed, clear, firm, and prepared with care. Students can perform the experiment in groups but must turn-in their own individual reports. **Please keep in mind that reports will be graded for their technical contents, format, completeness, and appearance. Students may be asked to demo the experiments at any time.**

**Oral Presentation**

A final oral presentation is required for all students. Presentation will be performed by groups of two to three students per group. The project topic will be announced at the middle of the semester and students are expected to carry out the research independently with minimum help from the instructor. There will be no written project report required but the presentation materials. All presentation materials must be turned-in before the presentation day (both the hard- and soft-copies are required). Approximately, the presentations will be presented on the last two class meetings of the semester.

**Exams**

There will be one midterm exam and a comprehensive final exam. The date of the midterm exam will be determined. **The final exam date is Monday December 16 2002, 19:45 – 22:00**

- All exams will be CLOSE BOOK exams
- Exams will cover the assigned reading materials, discussed materials in the lectures, and information from the lab exercises and the design projects.
- There will be no make-up exams (in very special circumstances, written excuse and official proofs are required for making-up exam).

**Grading Policy**

The overall course grades (letter-grades) will be based on the standard shown below:

- 90% - 100% = A-, A, and A+
- 80% - 89% = B-, B, and B+
- 70% - 79% = C-, C, and C+
- 60% - 69% = D-, D, and D+
- Below 60% = F

Where the weights of all assignments and examinations are:

- Laboratory exercises and projects: 50%
- Final project presentation: 15%
- Midterm examination: 10%
- Final examination: 25%

**Important Dates**
Monday, August 25: First day of instruction - Add/Drop begins
Friday, September 12: Deadline to drop for fee refund or for adjustment of fees
Last day to drop or withdraw without "W" grade assigned
Friday, September 19: Last day to add courses and register late
Instructor drop deadline
Last day to request grade options - Academic Renewal, CR/NC, Audit

Wednesday, November 26 to
Friday, November 28: Thanksgiving Holiday
Tuesday, December 9: Fall 2003 last day of instruction
Monday, December 15: Final exam, 19:45 – 22:00
EE@SJSU
Honesty and Respect for Others and Public Property

EE HONOR CODE

The Electrical Engineering Department will enforce the following Honor Code that must be read and accepted by all students.

“I have read the Honor Code and agree with its provisions. My continued enrollment in this course constitutes full acceptance of this code. I will NOT:

• Take an exam in place of someone else, or have someone take an exam in my place
• Give information or receive information from another person during an exam
• Use more reference material during an exam than is allowed by the instructor
• Obtain a copy of an exam prior to the time it is given
• Alter an exam after it has been graded and then return it to the instructor for re-grading
• Leave the exam room without returning the exam to the instructor.”

Measures Dealing with Occurrences of Cheating

• Department policy mandates that the student or students involved in cheating will receive an “F” on that evaluation instrument (paper, exam, project, homework, etc.) and will be reported to the Department and the University.
• A student's second offense in any course will result in a Department recommendation of suspension from the University.

A Message from EE177 Instructor

In addition to EE Honor Code, EE177 students understand that professional attitude is necessary to maintain a comfortable academic environment. For examples:

- I DO NOT just skip the lecture and then ask the instructor to summarize the lecture for me later on. Office hours are for students to have questions, not for the instructor to summarize the lecture for any specific student.
- I come to the class on time and leave the class at the end of the lecture.
- To minimize possible tension during the exams, I WILL follow the exam rules closely.
- I work on the lab reports and final project by myself.
- I understand that long-term learning is my responsibility and so I always keep it up

I strongly believe that NOT any statement similarly to examples below can be used:

- I am working full-time and so do not have enough time for the class.
- I have quite many classes this semester and so I do not have enough time for the class.
- I just need a passing grade to graduate this semester.
- I live far away from the campus and so I can not come to the class often.
- etc., etc....

PLEASE DO NOT CONSUME FOOD IN THE CLASSROOM