University of California at Berkeley
Mechanical Engineering

ME 230: Real Time Software for Mechanical System Control

Syllabus: Fall, 2008

Course Description

ME230 covers software design and implementation methodologies suited to the control of complex mechanical systems. The design methodology allows for the operational description of mechanical systems in a way that can be presented to semi-technical personnel as well as serve as a basis for software development.

Implementation is based on mid-level language such as C and high level graphical language such as LabVIEW. Implementation methodology is presented with software portability as the primary emphasis. Students work in teams to design and implement solutions to problems of increasing complexity using prototype lab equipment, including a design project for which they must formulate objectives

Topics Covered
C and LabVIEW programming principles; task and state design methodology; principles of real time computing; real time implementation issues; feedback control basics; operator interface.

Course Objectives
By the conclusion of the course, students should be able to:
- Assess the relative difficulty of a problem
- Outline a solution to it
- Estimate resources required to solve the problem
- Develop and document a design for the control software
- Identify critical safety issues
- Implement a prototype solution
- Test and evaluate the solution
- Work as part of a team to accomplish these goals

Basis for Grading
- 8 Lab exercises
- Progress reports
- Final project proposal
- Mid-term exam
- Final project

Lab

The lab is the heart of this class. Most of the individual work to be done revolves around lab projects and the lectures are keyed to the labs.

The lab is located in room 122 Hesse Hall and is available 8:00 AM – 5:00 PM each weekday. Evening hours and Weekends may be available upon special request.

The lab contains a variety of mechanical systems that can be controlled and computers with appropriate interfaces for controlling them. The computers are PCs running Windows and the real-time operating system LabVIEW Realtime.

What Can Be Used – Outside Material; Academic Honesty

You can use any material that you can find, anyplace you find it **AS LONG AS YOU REFERENCE IT**. If you are using code or solutions that you got from somewhere else (the web, another student, previous work, etc.) you are then expected to carry the solution well beyond the point attained by the work you are referencing. Your total effort should be the same but if you can use "found work" you will be able to explore advanced techniques.

Lab Exercises

There are eight lab exercises of one or two weeks each. They combine exercises associated with learning C and LabVIEW to acquire data from and control mechanical hardware (mostly motor-driven systems). The exercises represent an increasing level of complexity, requiring more sophisticated software techniques for later exercises.

Each exercise requires a final report in standard engineering format. Brevity is valued in all reports! The balance between completeness and brevity is difficult. An engineering report is normally written for two audiences: those who are trying to evaluate the work to see if it is relevant to their needs and those who are trying to reproduce what was done (the former are often the bosses of the latter). The usual report sections should be included:

> Title – make it descriptive ("Lab 1" is not a great title!)
> Abstract – must stand alone since abstracts are often published separately
> Introduction – motivation and problem description
> Body – how the problem was solved
> Results – from tests used to show whether specifications have been met
> Discussion – relate results to specifications
> Conclusions – your opinions on what has been achieved

Group Work

All of the lab assignments are done by groups of no more than three to four students depending on the class size. Only the midterm exam is done individually. Grading is entirely by group. Groups are self-formed and can change from one assignment to the next.

The major reasons for group work are that most of this kind of work in industry is done in groups, the learning is richer when doing this work as part of a group, and the lab is utilized more efficiently by groups.

Group dynamics can sometimes be tricky. If there are problems in a group that you're having trouble solving on your own please come to see me. Don't wait – the earlier these kinds of problems are addressed, the better. Although problems do arise, on the whole the teamwork aspect of this class has been very beneficial.

Performance Specifications

Every exercise and the final project *must* have a specification for expected performance. The specification must be written before the work is done along with "acceptance tests" used to show whether they have been met or not.

The performance specification and associated testing will be given strong weight in grading. The issue is not whether the specification is met or not, but whether the testing and interpretation of results have been done thoroughly.

Final Project

The final project is more like an industrial design project than an exercise. In the final project the product is the goal. Any needed combination of technologies and skills can be used.

Picking the project objective is part of the project. The intent is that the product be strongly based on real time control software. There is no requirement any hardware be built. It is perfectly acceptable to use existing hardware in the lab, equipment in a research lab you are associated with, or other existing hardware. You are also free to build or modify hardware for the project. Keep in mind, however, that building hardware is a very time-consuming activity and the grade will be based mainly on the software control system design and implementation.

Finding the right level of complexity for the final project is important. If it is too simple getting a top grade is difficult even if the project is carried out well. Likewise, choice of something too complex makes it difficult to make enough progress to demonstrate your understanding. All of us are happy to discuss project plans with you. The final project proposal should document what you want to do and present the acceptance test specifications.

The final project includes a presentation. There is no separate grade for the presentation, but the presentation is considered as part of the overall project grade.

Progress Reports

Progress reports are due every week that a full report is not due (including the time the final project is being worked on). The progress reports are limited to two pages (including graphics, listings, etc. – nothing will be read beyond two pages) and should describe your progress during the week. "No progress" is not a satisfactory report!

MidTerm Exam

A mid-term exam will be held towards the end of the semester. It will cover material presented thus far. It could be in the form of a design essay, take-home work on a control program, etc.

Grading Matrix

	Value	Number	Contribution
1 week labs	5	5	25
2 week labs	10	3	30
Progress reports	2	6	12
Exam	10	1	10
Final project	25	1	25
TOTAL			**102**

Class Communication

Official class communications (changes in due dates, information on assignments, exam information, lab demo dates, etc.) will be either in class, by email, and through bSpace.

The bSpace site will be used for distribution of lab materials, sample software, etc.