Digital Control: Micro Systems Syllabus
Spring 2006, The School of the Art Institute of Chicago

Instructor: Dmitry (Dima) Strakovsky
T-Th 6:00pm -9:00pm

Course Summary:

This class is an exploration of the use of embedded micro-controllers to control a wide variety of mechanical or electrical devices. Possibilities include control of kinetic sculpture, custom performance interfaces, installations, presentation of sound or light, video control, and interactive works. Students learn to build and program their own micro-controller board, with an emphasis on techniques and approaches for the generation of temporal and spatial processes.

Course Content:

After a brief review of basic electronic concepts students are introduced to digital microcontrollers and C programming language. Through a variety of exercises students will become familiar with these tools and make them a part of their creative process. The class is structured in such a way as to allow students to explore the techniques introduced through the instructor's demonstrations, to gain hands-on experience with the subject, which is essential to future intuitive approach to the medium.

After the first, technical phase of the class, students pick the final projects and dedicate the rest of the class times to creating these works. At this point instructor will advise and direct each student's project in order to facilitate its completion at the end of the semester.

Instructor Contact E-mail:

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Required reading/materials:

Handouts provided by the instructor
Electronics kit to be purchased from Art and Technology Department.

Course Assignments and Activities:

Technical Assignments:	Will be equally distributed through the first phase of the course. Will involve hardware and software solution design.
Final Project:	A completed work or part of a work which involves the use of a microcontroller. Presentation of the work, consisting of description of both aesthetic and technical challenges and their solution methods.

Week 1

Review of electronics concepts + skill assessment
Defining the terms “digital and analogue” --> practical demos
Setting up a breadboard
Motors and transistors

Intro to MPLAB
Demo on burning the program onto a chip
Introduction to PIC16F88:
    brief look at the datasheet (non-engineering approach),
    figuring out where and what to connect :) how not to get lost
    Getting an LED to blink

Week 2
Intro to C -->
    Discuss the function of a compiler
    Dissecting the LED blinking program (introduction to C)
    Zero is a number!!!! :)
    Exercise: using variables (lengthen/shorten blinks)

    Exercise: using loops ("while" and "for" loops)
    Intro to conditional "if", "else" and "if else" statements
    Intro to modulo
    Exercise: Using conditional statements

Week 3
Review of the material presented
Introduction to arrays
    Exercise: write a short sequence for 3 LEDs
Controlling a motor (substitute motor+transistor for LED)-->
    review of transistor concepts
    motors and microcontrollers: power segregation, filtering out power
    supply noise, fighting reverse EM flow from a motor
    Exercise: write a sequence of on an off times for a motor

demo: observing motor control on oscilloscope, finding noise and taking it out
with wire placement and capacitors
    Introduction to PWM
    Dissecting simple PWM code example
    Exercise: fade up and down an LED

Week 4
Motor control continued -->
    Dissecting real world PWM code example
    Exercise: speed up and down a motor
    Using flags-->
        creating breath-like LED sequence

Review of output code/concepts

Week 5
Connecting PCs to microcontrollers via serial port

Hyperterminal
testing serial cable
wiring up level converter IC

Communicating to PC
printf example
Adding simple switches-->
Setting up inputs on PIC
reading switch closure
using printf to send info to computer
Exercise: count how many times the switch was closed
Discuss pulldown resistors and debouncing <-- why do we need them
Exercise:Write code using delays to debounce the switch

Week 6
Analogue to digital conversion-->
Review of the sample code
Review of voltage divider concepts
Exercise: implement the demo code using potentiometer, get a feel for the values as you are twisting the pot knob

Real world C: breaking thing into functions
Discuss advantages of making code modular with functions
Example: A more complex A2D example: simulating a comparator, working with thresholds
Exercise: Play with the code and rewrite the threshold levels

Week 7
Boolean statements -->
Reading input from multiple switches

Getting input from PC
Example: scanf sample code
Exercise: write your own code to control motor state (on/off) from HyperTerminal
try to write code to control speed of a motor

Intro to Interrupts -->
why we need interrupts refer to the failure of speed control code
Example: serial interrupt
Exercise: writing motor control code using serial interrupt

Week 8
Notes and discussion on where to buy materials cheaply: Catalogs, on-line sources, local, national, international.
From this point on, ALL of the demos are optional. It is up to the student wherever s/he wants to spend time on the final project or on the demo.

DEMO: timer interrupts, revisiting PWM code

Begin working on Final Projects.
one on one catch up + reviews
Turn in the first draft of the final project proposals

Week 9
DEMO: timer interrupts, revisiting PWM code
control code discussion
one on one catch up + reviews
Continue working on the final projects

Week 10
DEMO: timer interrupts, writing a state machine
one on one catch up + reviews
Continue working on the final projects

Week 11
DEMO: Serial register interrupts
one on one catch up + reviews
Continue working on the final projects
Review of status of the final projects

Assignment: write the final version of the final proposal
Individual meeting focusing on the progress and goals of the final project.

Week 12
DEMO: Communication to other PICs and external devices using I2C or SPI
Continue working on the final projects

Week 13
Continue working on the final projects

Week 14
Final Critiques --> presentations of the final projects: concept critique/suggestions; presentation of the code and circuitry: critique/suggestions

Note: Depending on the interests of students in a particular topic DEMOs might be shuffled around and/or appended. Possible topics might include ethernet connectivity, sound playback, stepper motor control, servo motor control. Please see instructor if you are interested in a specific topic.

Please refer to code and schematic examples at www.shiftingplanes.org/mcu_class