The class is designed to provide an experimental environment to learn theoretical and practical ways to interface electronic circuits and various transducers to and with microprocessors. This is a ‘hands-on’ class and the student is expected to participate in experiments in class as well as assigned projects that support other Physical Computing courses in the Program. This course involves theory, construction, programming, debugging and documenting microprocessor-controlled projects. Some fundamental computing concepts are covered in the first four meetings, while throughout the course specific applications are examined. Students will fabricate and troubleshoot at least two digital application demonstration boards and around week 8 an approved term project, usually a collective effort with other team members to successfully complete this course. In addition, some independent work is required and essential for successful completion of this class.

Digital and electronics fundamentals (weeks 1, 2 & 3)

A. Ohm’s Law, AC and DC theory and simple circuits
B. Reactance and transformers, energy and power
C. Frequency determining components of capacitors and inductors
D. Semiconductors, diodes and transistors and the IC
E. Bits, bytes, baud and digital numbering systems
F. Digital logic building blocks
G. Simple logic, binary encoding and applications

Computer (µP) fundamentals (week 4 & 5)

A. Microprocessor architectures
B. CPU (central processing unit)
C. Arithmetic logic unit (ALU)
D. Timing and control
E. Input/output (I-O)
F. Address and data bus
G. Memory; RAM, ROM, FLASH and magnetic storage
H. Instruction sets and command executions
I. Assembly and high-level languages overview

Computer interfacing (weeks 6, 7 & 8)
A. Parallel and serial interfacing (includes demonstrations)
B. Registers, memory and storage
C. Analog to digital (A/D) circuits (student fabricates)
C. I/O control applications and techniques
D. Operational amplifiers (includes experiments)
E. D/A converter experiments with simple software
E. Peripherals and interrupt driven devices

Basic Input and Output (I/O) peripheral interfaces (weeks 9 & 10)

A. Keyboard and keypad scanning techniques (with demos)
B. Interfacing LEDs and LCD displays (individual student project)
C. Switch multiplexing
D. Oscilloscope demonstration of waveforms used in some lectures
E. Interrupts

Practical interface methods (weeks 11 & 12)

A. Static Input/Output latching (may require some programming skills)
B. Dynamic I/O interfacing and serial to parallel devices
C. Transducers
D. Application of resistance, current and voltage (Ohms Law)
E. Measuring techniques for voltage, resistance and current

Team and term application project (weeks 13 & 14)

A. Each student is required to collectively participate in an approved group term project dealing with an approved microprocessor (µP) interfacing application and present both a written summary or their own experiences and also a presentation to the Class with their team.

B. Criterion for grading will be based on evaluation of the answers to the following questions:

- How well did they present their project?
- How good is the project or application?
- What was the learning?
- How well did the group function as a whole?
- How much innovation was involved?
- What is the quality of recommendations and summary?
- How successful at getting and using needed information?
SALIENT COURSE OBJECTIVES

To develop an understanding how microprocessor circuits and software operate and knowledge as to how they are configured to solve problems of real-time control.

Provide an OVERVIEW of the popular interfaces applied to the microprocessor and explore the range of applications and practical performance that can be achieved.

DEMystify the technology and address the problems of communicating with design engineers and programmers.

Emphasize a USER-ANALYSIS to $\mu$P interfacing; study and learn some practical designs and develop effective solutions to achieve practical solutions for interfacing various transducers and sensors.

COURSE TEXT

There is no formal text for this course or single book. Course reference material will be taken from articles and chapters in programming, data, interfacing and experimenting books. These include:

The Quintessential PIC Microcontroller by Sid Katzen
Embedded Design with the PIC18F452 by John Peatman
Transducer Interfacing Handbook by Analog Devices
Operational Amplifiers by Clayton & Newby
Programming and Customizing PICmicro Microcontrollers by Myke Predko
Stamp 2 by Tom Petruzzellis
PIC, Your Personal Introductory Course by John Morton
Basic Electronics Technology by Radio Shack
Understanding Basic Electronics by the American Radio Relay League
Programming and interfacing with experiments by Marvin De Jong
PIC in Practice by D. W. Smith
Applying PIC18 Microcontrollers by Barry B. Brey

COURSE COMPONENTS

Lectures and classroom demonstrations
Student experimentation and construction projects
Invitational lectures
Group technical workshops
STUDENT GRADES

Grades are based on three salient elements:

1. Class participation, hand-in assignments and attendance.
2. Approximately three (3) unannounced quizzes or student presentations.
3. Assigned term project (50% shared grade done by a project group of 4 or 5 and balance derived by summary report submitted on an individual basis) and 50% by a written project summary.

Elements 1, 2 and 3 are weighted one-third \((1/3)\) each. Make-up assignments can be arranged in advance for anticipated missed material. Audio recordings of the lectures are permitted. Extra credit opportunities are available (if approved up till 1 week before final grades). An approved title must be authorized in advance from the instructor for the term project. Appropriate titles include (in some cases) work related to but outside the Advanced Technology Class.

NOTES:

1. Three absences will cause an automatic drop of one grade.
2. Optional or supplemental tutorials may be scheduled.
3. Gary Schober’s home is (973) 764-3365 (Lake house) and BVS office daytime at (732) 548-3737
   - Email at School is GWS4@NYU.edu or home at Gschober@Warwick.net