ENGR 323L: Microprocessor Systems
Department of Engineering, Trinity College, Spring 2026

Instructor: Taikang Ning, Ph.D. Professor of Engineering

Office hours: Tue & Thur 10:50-11:50AM @ MECC-343

Lectures & Labs: Mon & Wed 1:30 PM-4:10 PM @ MECC-320

Course outline: A hands-on study of design and implementation of microcontroller embedded systems. Course topics include computer system architecture, CPU function, system bus structure, memory mapped I/O, interrupts, precision-time control, multi-tasking. serial communication protocols, analog to digital (A/D) conversion, and pulse width modulation (PWM) based control. In laboratory, students begin with schematics design, building microcontroller interface circuits, and programming with EEPROMs to make a complete embedded system. Assembly and C/C++ languages are introduced and used extensively in laboratory projects. Projects with different tasks are designed to familiarize students with applications and challenges concerning an embedded system.

References:

- *http://galia.fc.uaslp.mx/~cantocar/microprocesadores/EL_Z80_PDF_S/8051.PDF*
- *http://www.circuitstoday.com/8051-microcontroller*
- *The 8051 Microcontroller* (3rd ed.) by Kenneth J. Ayala
- *Silicon Lab C8051F120DK Manual*

Grading Policy: Exam1 and Exam2 - 60%, Lab & Programming Assignments – 40%

Lecture Topics:
- Microprocessor architecture design: Reduced Instruction Set Computer (RISC) vs. Complex Instruction Set Computer (CISC), general-purpose CPU, Digital Signal Processor (DSP) and microcontrollers (µC)
- Architecture of basic 8051 microcontrollers and special function registers (SFRs)
- 8051-based embedded system with required memory expansion with RAM and ROM, I/O ports, power supply, crystal oscillator, and interrupt connections
- Assembly language and instruction sets of 8051 (MCS-51)
- Timers, internal and external interrupts, multiple interrupt latency control, precise timing control

- Analog to Digital (A/D) conversions: sampling frequency, anti-aliasing filter, quantization errors, transducers and calibration, and signal conditioning
- Serial communication through universal asynchronous receiver and transmitter (UART)
- ANSI C/C++ programming fundamentals; embedded-C programming: syntax, main program, header file, variable declaration, functions, and interrupt service routines
- LCD display interface – circuit interface, control registers configuration
- Pulse width modulation (PWM) and motor control
- Embedded systems design

Laboratory Projects:

- Schematic design of 8051embedded systems
- wire-wrapped 8051 embedded system using multiple interrupts
- Generation of music notes
- LCD interface
- Multiprocessor communications with UARTs
- Motor control using pulse width modulation (PWM) and PID controller
- ECG and respiration monitoring (with A/D and bio-instrumentation)

Calendar Reminder
- 2/19,20 Trinity Day (no class)
- 3/14-22 Spring Vacation
- 4/29 Last day of class
- **Exam-1 March 11**
- **Exam-2 April 22**