



Instructor Information	Class Times
Instructors: Asst.Prof. Surapont Toomnark Asst.Prof. Sanan Srakaew Aj. Nuntipat Narkthong E-mails: surapont@cpe.kmutt.ac.th sanan.sra@mail.kmutt.ac.th nuntipat.nar@kmutt.ac.th Facebook: CPE328 Embedded System (2/63) Telephone: 02-470-9083 Office Hours: Fri: 13.30-16.30, or with an appointment. TAs: Mr. Sirawit Lappisatepun (P'Toey)	Wed 8:30 – 10:30, Lecture via MS Team (A/B/RC) Wed 10:30 – 12:30, Lab via MS Team (RC) Fri 8:30 – 10:30, Lab via MS Team (A) Fri 10:30 – 12:30, Lab via MS Team (B) Fri 17:00 – 20:00, Lecture / Lab via MS Team (Inter)

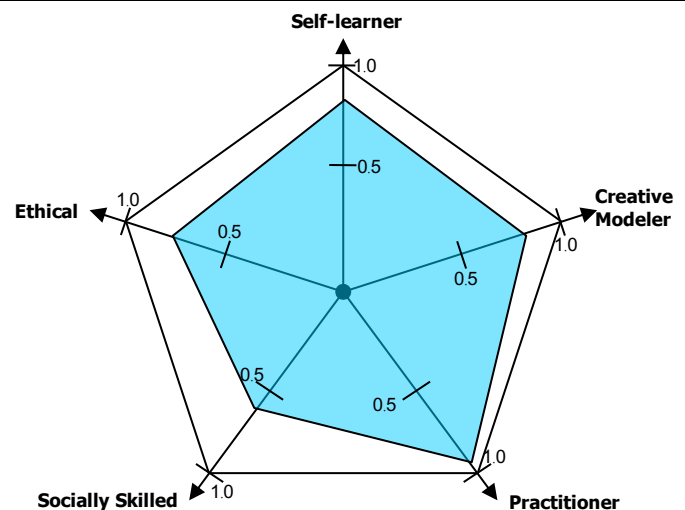
Course Objectives

The key objective of this course is to provide students hands-on experiences in embedded system design and programming. A project-based approach will be exploited.

The Computer Engineering Department has a new mission to use innovative hands-on, active learning techniques to develop 5 distinct student characteristics:

- 1) Self-Learner
 - prepare readings before class for group discussion/quiz
 - self-study for doing projects
- 2) Creative Designer/Modeler
 - create models for projects and assignments of real-life problems
- 3) Practitioner
 - projects and assignments with real-life type problems.
- 4) Socially Apt
 - working in teams of 5 on projects
 - participating in group discussion
- 5) Ethical
 - focus on the importance of ethics and individual integrity

The shaded area in the graph is the goal of this course to develop you in each dimension. **Ethics** is a key characteristic we would like all our students to possess.



Five Desired Characteristics of CPE Students

Ethics means that any work you submit for credit is to be your work. For homework assignments and projects, general discussion with your classmates regarding the requirements or the approach to be taken is permitted.

Homework assignments and/or reports are due prior to the class time. Your submitted assignments/reports must be yours. **Class attendance** is very important. Showing up late causes 10% deducted in in-class exercises. Cell-phones must be **turned off** before you come to class and not allowed to use during class time. They are disruptive and annoying. If we hear a cell-phone ringing during a quiz, I will assume you are cheating. **Laptop** usage is for assigned classwork. **Facebook, Messenger, Line** and **game playing** are prohibited. If we see you playing game or using Facebook, Messenger, Line you will be asked to leave the room.

Course Description

Embedded microcontrollers, sensors and actuators, embedded programs, real-time operating systems, low-power computing, reliable system design, design methodologies. Experiments focus on hardware design rather than proprietary approaches.

Course Learning Outcomes

1. Understand basic elements in embedded systems.
2. Design and program embedded systems given specific requirements.
3. Able to write technical reports and give presentations.
4. Able to work as a team to build a practical project.

Required Texts

There is no required textbook for this course however the following materials will be used frequently in lectures and labs

- ATmega48A/PA/88A/PA/168A/PA/328/P Data Sheet (free to download from Microchip website)
- The AVR Microcontroller and Embedded Systems Using Assembly and C by Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, Prentice Hall, 2011. (available in KMUTT library)

Software Tools

- MPLAB X + AVR GCC Toolchain
- Tinkercad Circuits
- KiCad EDA

Grading Policy

Final grades are based on performance indicated by student in-class exercises, lab reports, homework assignments, quizzes, projects, mid-term, and final exam grades. The final grade will be calculated according to the following weights:

Midterm and Final Exam:	40%
Projects (Mini Project + Final Project)	40%
Quizzes / in-class exercises + labs:	20%

CPE 328 Schedule (tentative)

Week#	Lectures	Lab Topics
1 (Jan 20,22)	<ul style="list-style-type: none">- Introduction to Embedded System- AVR Microcontroller History / Architecture	Lab 1: Basic Electronic Circuits with Tinkercad Circuits <ul style="list-style-type: none">- Electronic components- Digital logic (TTL/CMOS, Fan-in, Fan-out)- Circuit prototyping with breadboard
2 (Jan 27,29)	<ul style="list-style-type: none">- AVR Hardware Design- Polling & Interrupt I/O	Lab 2: AVR I/O Programming <ul style="list-style-type: none">- I/O ports programming- LED, push button and Matrix keypad interfacing
3 (Feb 3,5)	<ul style="list-style-type: none">- Parallel communication- Asynchronous serial communication (UART, RS-232, RS-485)- Interfacing IC (MAX232, MAX485, etc.)	Lab 3: Serial/Parallel Communication <ul style="list-style-type: none">- AVR UART Programming- 16x2 LCD module interfacing

4 (Feb 10,12)	- Analog-to-Digital Converter - Analog Comparator	Lab 4: AVR ADC/Analog Comparator - AVR ADC/AC Programming - Analog sensor interfacing circuit (Op-amp)
5 (Feb 17,19)	SPI Communication Protocol	Lab 5: AVR SPI Programming
6 (Feb 24, 26)	I ² C Communication Protocol	Lab 6: AVR I ² C Programming
7 (Mar 3, 5)	Timer (Counter)	Lab 7: AVR Timer (Counter)
Mar 8-16	Midterm Exam Period	
8 (Mar 17, 19)	Timer (Waveform Generator / PWM)	Lab 8: AVR Timer (PWM) - AVR Timer Programming - DC load interfacing circuit (Transistor, H-Bridge, Opto-isolator) <i>Mini Project #1 Due: March 19, 2020</i>
9 (Mar 24, 26)	Introduction to PCB Design with KiCad EDA	Lab 9: PCB Design with KiCad (Part I)
10 (Mar 31, Apr 2)	PCB Design for Manufacturing Techniques	Lab 10: PCB Design with KiCad (Part II)
11 (Apr 7, 9)	FreeRTOS	Lab 11: AVR Programming with FreeRTOS
Apr 12-16	Songkran Holiday	
12 (Apr 21, 23)	Microcontroller hardware/software platforms e.g. Arduino, ARM mbed, Micropython, FreeRTOS etc.	Lab 12: Basic Arduino Programming <i>Mini Project #2 Due: Apr 23, 2020</i>
13 (Apr 28, 30)	Survey of alternative microcontroller architectures e.g. PIC, STM32, ARM Cortex-M etc.	Lab 13: XXX Microcontroller Programming
14 (May 5, 7)	Wireless Communication for Embedded System (Wi-Fi, Bluetooth LE, LoRa, Zigbee)	Lab 14: WiFi and BLE Programming with Arduino & Espressif ESP32 MCU
15 (May 12, 14)	-	-
May 17-21	Final Exam Period <i>Final Project Due + Presentation: May 17-21, 2020</i>	