

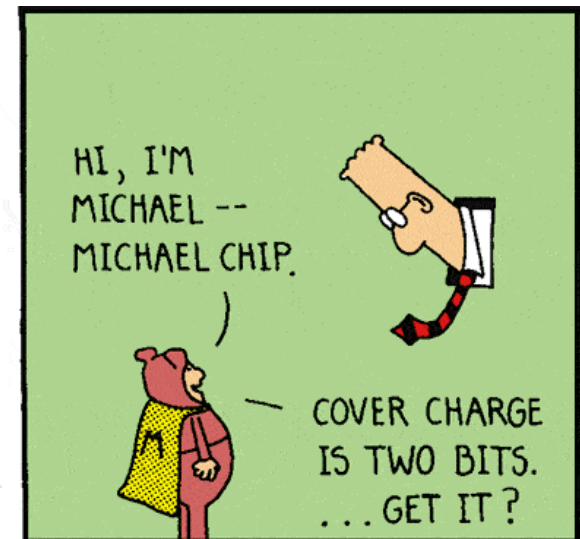
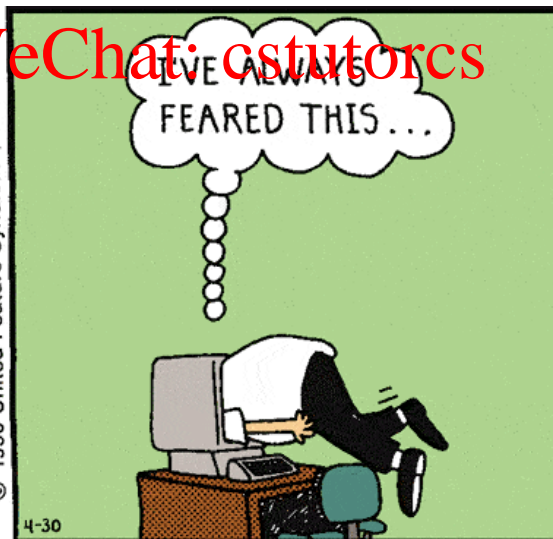
Lecture 1

ECE 2560 Introduction to Microcontroller-Based Systems

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<https://tutorcs.com>

WeChat: cstutorcs



Syllabus



Instructor: Irem Eryilmaz

Email: eryilmaz.4@osu.edu

Office: Dreese Lab 660

Class schedule: We Fr 4:10 pm – 5:05 pm Dreese 113

In person

Office hours: To be announced

<https://tutorcs.com>

Communication: Email – Both ways

WeChat: estutorcs

When sending email please start subject with “**ECE 2560**”

Email availability: I usually reply to emails within 24 hours on OSU days

No promises over weekends or official holidays

No promises right before a deadline when I receive a burst of student email

⇒ Do not wait until the very last moment

Learning Objectives



ECE 2560 Introduction to Microcontroller-Based Systems

- Hardware and software organization of a typical microcontroller
- Assembly Machine language programming
- Interfacing peripheral devices, and input-output programming
- Real-time computer applications

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Course Goals

- Learn the architecture, programming, and interface requirements of a commercially used microprocessor **TI MSP430FR6989**
- Learn to interface a microcontroller to memory, parallel ports, serial ports, etc.
- Learn to apply microcontroller systems to solve real-time problems

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2560 within ECE Courses



Prerequisites and Co-requisites:

Prereq: 2000, 2060, 2061, ..., or 2001 and prereq orconcur: 2000.07 or 2017; and EnGraph 167, CSE 1221, 1222, Engr 1281.01H, 1281.02H, 1222, Engineer 192.01H, or 192.02H, and enrollment in ECE, CSE, or EngPhysics major; or prereq or concur: 2010 or 2067, and permission of department

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Required Background: <https://tutorcs.com> Mostly self contained

ECE 2060 Digital Logic WeChat: cstutorcs will help

- Numeral Systems, 1's and 2's complement – will review starting on Fr

Basic understanding of programming

- Flowcharts, pseudocode etc.
- Some fundamental algorithms
- Conditional statements (`if`), loops (`for`),
- Pointers and addressing – very straightforward in assembly

2560 within ECE Courses



What's next?

ECE 3567 Microcontroller Lab

- Laboratory in which a microcontroller is used to interface real-world hardware to make a functioning system
- Same microcontroller (MSP430F-R6989 LaunchPad Development Kit), same IDE (Code Composer Studio) but C instead of assembly

<https://tutorcs.com>

ECE 5362 Computer Architecture and Design (Prereq: 2560 and 3567)

ECE 5462 HDL Design and Verification (Prereq: 5362)

ECE 5465 Advanced Microcomputers (Prereq: 5362)

ECE 5466 Embedded Computer Systems (Prereq: 5362)

ECE 3905 and ECE 4905 Capstone Design I and II

For more information: undergraduate academic advisor

Required Materials



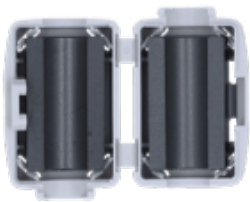
Required Experimenter's Board

- MSP430FR6989 LaunchPad Development Kit

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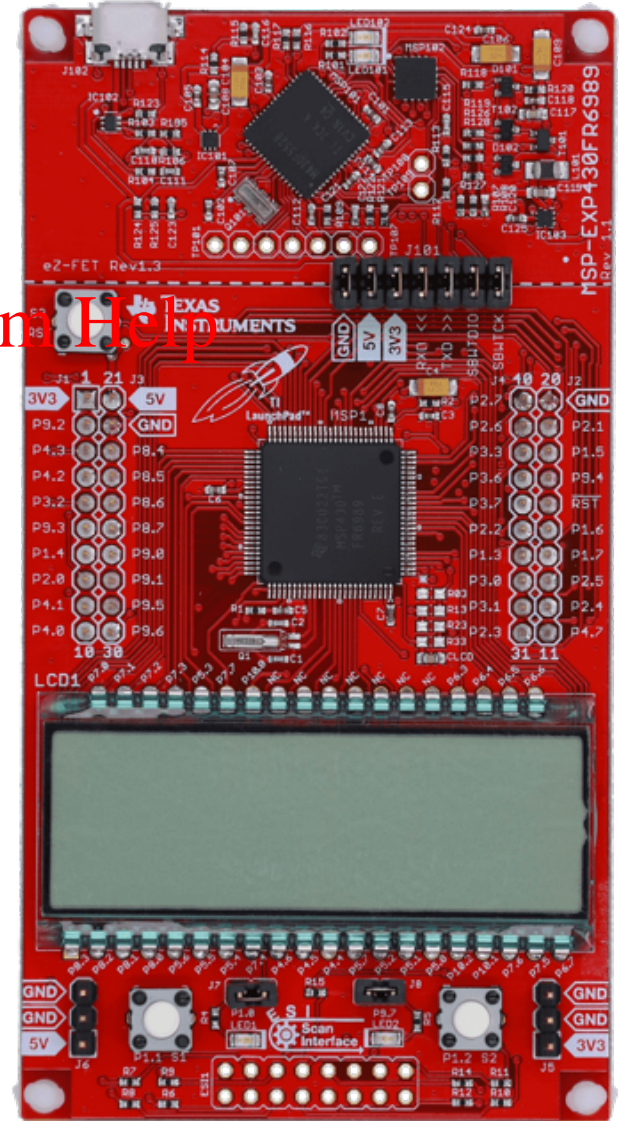
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Snap on
ferrite bead



micro USB cable



Required Materials



Required Experimenter's Board:

- MSP430FR6989 LaunchPad Development Kit

Where to get it?

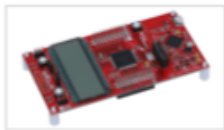
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<https://www.ti.com/tool/MSP-EXP430FR6989>

Order this hardware only

<https://tutorcs.com>

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DEVELOPMENT KIT

MSP-EXP430FR6989 – MSP430FR6989 LaunchPad Development Kit

Log in to order

\$20.00 (USD)

 Log in to view
inventory

[Buy from a distributor](#)

digikey.com \$24 + ship – only 21 in stock!

mouser.com \$26.60 + ship – 508 in stock

amazon.com -- \$\$\$\$

What else do I need?



A computer with **Code Composer Studio (CCS)**

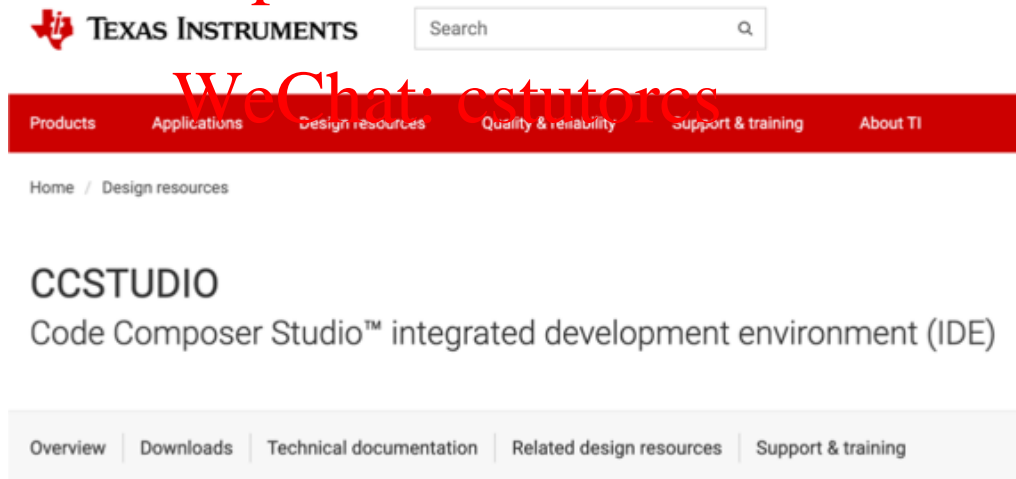
Integrated development environment (IDE) we will use to

- write code
- build
- upload to development board
- run, test, debug...
- complete almost all assignments for this class

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Freely available from ti.com for different platforms

<https://tutorcs.com>



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ECE Windows computer labs have CCS up and running

Other Materials



Optional Reference Book:

- *MSP430, Microcontroller Basics*
John H. Davies, Newnes, First Edition
ISBN- 978-0-7506-8276-3
- No reading assignments
- No homework/quiz questions

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<https://tutorcs.com>

Instead we will check TI user guides

- SLAU627A.pdf
- SLAS789D.pdf
- SLAU367O.pdf

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Discord channel for discussions

- Link in Carmen, please join with your real name and keep the community going

Assignments and Grading



Assignments and % of Class Grade

- | | | |
|-----------------|---------|---------------------------------------|
| • Quizzes | [25%] | + Graded Surveys |
| • Midterms 1& 2 | [30%] | e.g., Office Hours Survey due Tuesday |
| • Project | [20%] | Expect |
| • Final Exam | [25%] | • a Mid-semester feedback survey |
| | | • a Final survey |

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Most assignments will be take home

- Last semester **all** assignments were take home and it worked fine
- Except many students completely forgot their way into the classroom

Attendance

- Still not mandatory, but highly encouraged
- Still plan to post lecture videos to Carmen – there might be delays/gaps
- After the first two weeks we will do in class coding – bring your laptop
- If too many students forget their way into the classroom, might do some in class quizzes as a reminder



Policies Around Assignments

You will have one week to work on your assignments

- While the assignments can be done in a few hours

This will give you a lot of flexibility with your timing

- Quizzes cannot be made-up
- Midterm and final examination may be made-up only due to illness **that lasts the whole week of the assignment** (a doctor's note is required)

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Re: SLDS accommodations

- SLDS does not proctor take home exams
- Take home format already enables reduced distraction testing setting
- You can easily take 1.5x or 2x or 5x with your take home exam

Please reach out if you have any concerns



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Questions?

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Microcontrollers



ECE 2560 Introduction to Microcontroller-Based Systems

- Hardware and software organization of a typical **microcontroller**
- **Assembly / Machine language** programming
- Interfacing peripheral devices, and input-output programming
- Real-time computer applications

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What is a **microcontroller**?

How is it different from a **microprocessor**? Is it even different?

What is **assembly language**? What is **machine language**?

Why do we bother learning all these things?

Computers



There are **two types of computers**

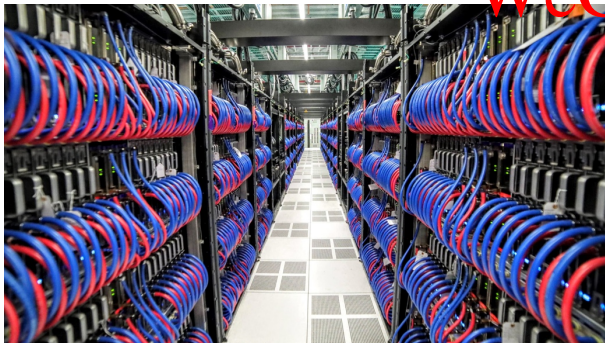
- 1. General-purpose computers**
- 2. Embedded computers**



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Two Types of Computers



1. General-purpose computers

- Runs any type of SW
- Redundant resources
- Multiple peripherals
- Powerful processors
- Large data / program storage
- Operating system (OS)
- Multiple chips: e.g. CPU + RAM + hard drive
- **Distributed architecture**
- \$\$\$\$
- ~400 million PCs sold a year

2. Embedded computers

- Dedicated to one application
- Minimal resources needed
- Respond to some inputs: e.g., button press or sensor input
- Send **control** signals to sub-systems ⇒ **microcontroller**
- Small data / program storage
- Mostly implemented on a single IC
- **System on a Chip (SOC)**
- \$
- 25 billion MCUs sold in 2018

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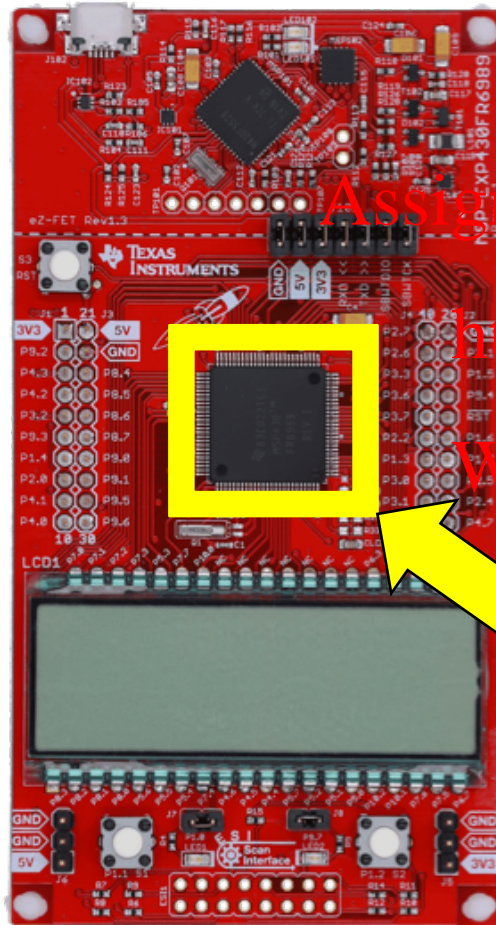
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MCU

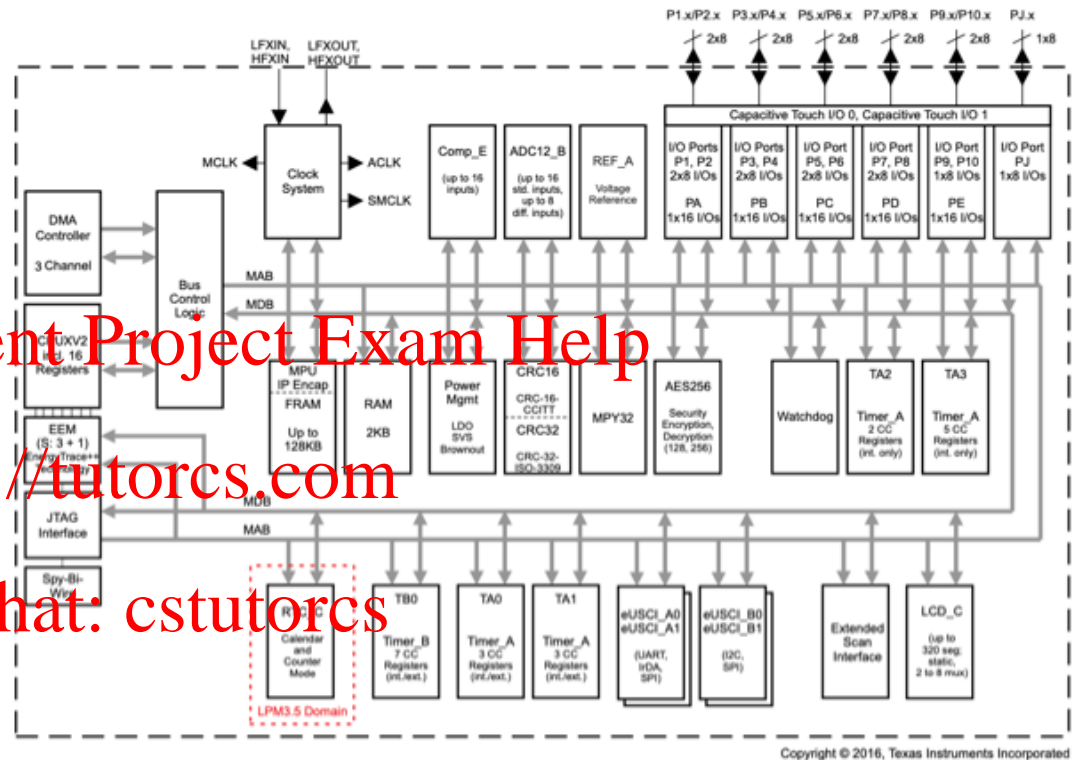
i.e., Microcontroller Unit



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Assembly Language



Low-level language that is closely tied to the **machine code** instructions of a processor

Machine code:

- Every processor has a set of instructions
- Each instruction is a numerical value composed of **opcodes** and **operand**

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`mov.b #0001000b, &P2OUT`

`42F2 0029`

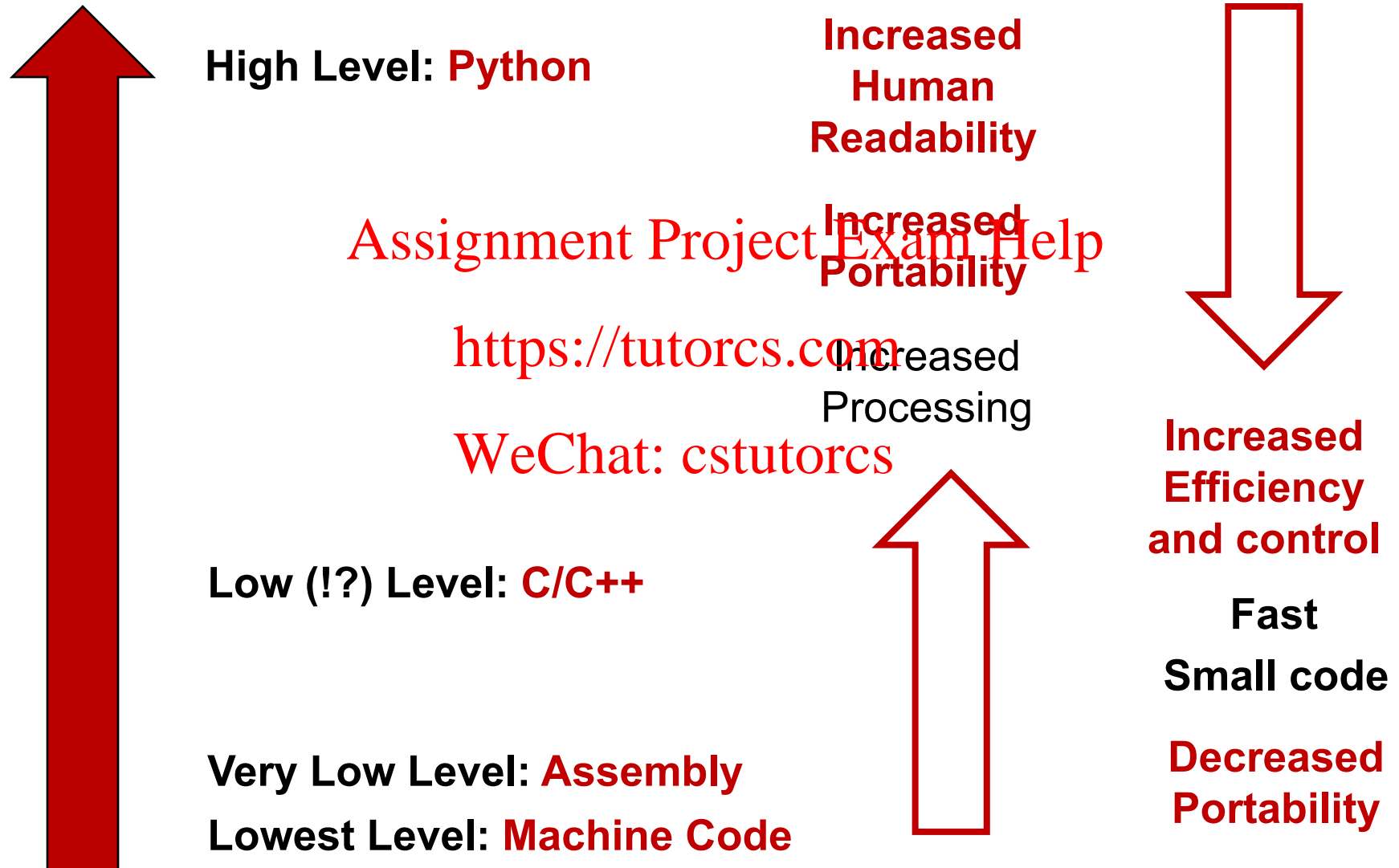
Assembly

Slightly more human
readable **mnemonics**

Machine code

Numerical values –
binary for the processor
hex for compact notation

Levels of Languages



Why Assembly?



Assembly is

- ✗ not very human readable
- ✗ not portable: every processor has its own assembly

but

- ✓ allows for higher control over the resulting machine code
- ✓ faster
- ✓ smaller code

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Modern compilers are better in producing more efficient machine code from C

More MCU applications use C – embedded C ECE 3567 MCU Lab

Learning assembly is more than knowing another programming language – it allows you to understand how a processor works and allows you to write better programs even when using other languages

Revisiting Learning Objectives



Official Course Goals

- Learn the architecture, programming, and interface requirements of a commercially used microprocessor
- Learn to interface a microcontroller to memory, parallel & serial ports, etc.
- Learn to apply microcontroller systems to solve real-time problems

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My Version of Course Goals

- Practice and develop problem solving skills
- Practice and develop clear thinking skills
- Learn to debug code
- Learn to test code

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Some Student Outcomes



- I had two things that stuck out to me the most: “The increase in my critical thinking to solve problems”
- When I used to code, I used to look at problems from more of a syntax point of view, now I look at it more from a logic point of view and it has made coding so much easier.
<https://tutorcs.com>
[Assignment Project Exam Help](#)
- The most important thing I learned is how to properly debug code. This is the first class I have taken here that involves coding that actually went through a method on how to debug code.
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- In many other labs/classes in ECE we just follow instructions and copy code without needing to understand it. In this class, we write the code ourselves, which forces us to understand it. This made me feel a lot more accomplished when I was able to figure out the assignments, because it felt like I was doing something tangible on my own.