CS3503

Computer Organization and Architecture

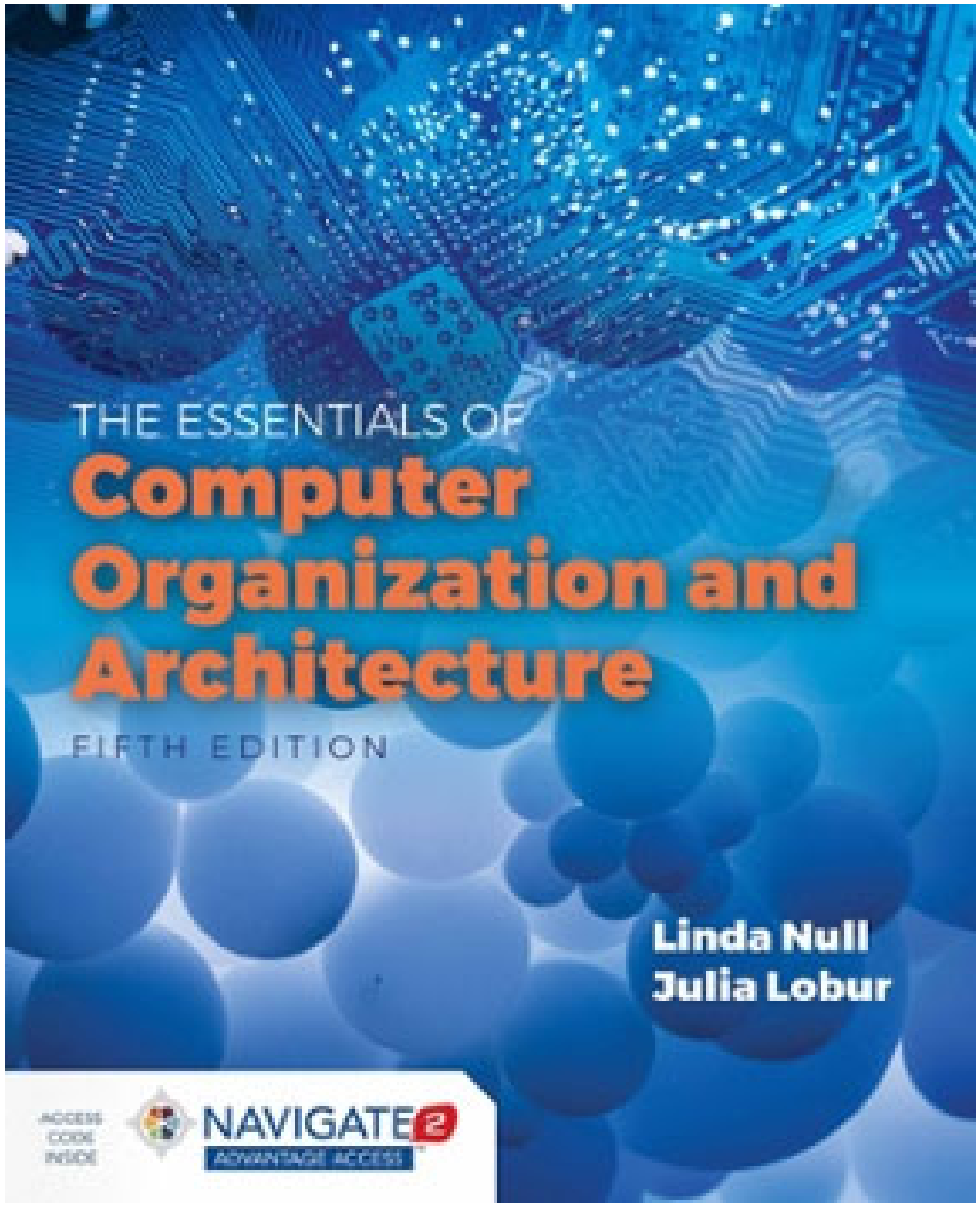
Why we are here?

- **Understand the working mechanism and some fundamental principles of computers**
  - **Because most of them are universally applied in computer science**
- **Design better programs, including system software such as compilers, operating systems, and device drivers.**
  - **Even optimize program behavior.**
  - **Evaluate computer system performance.**

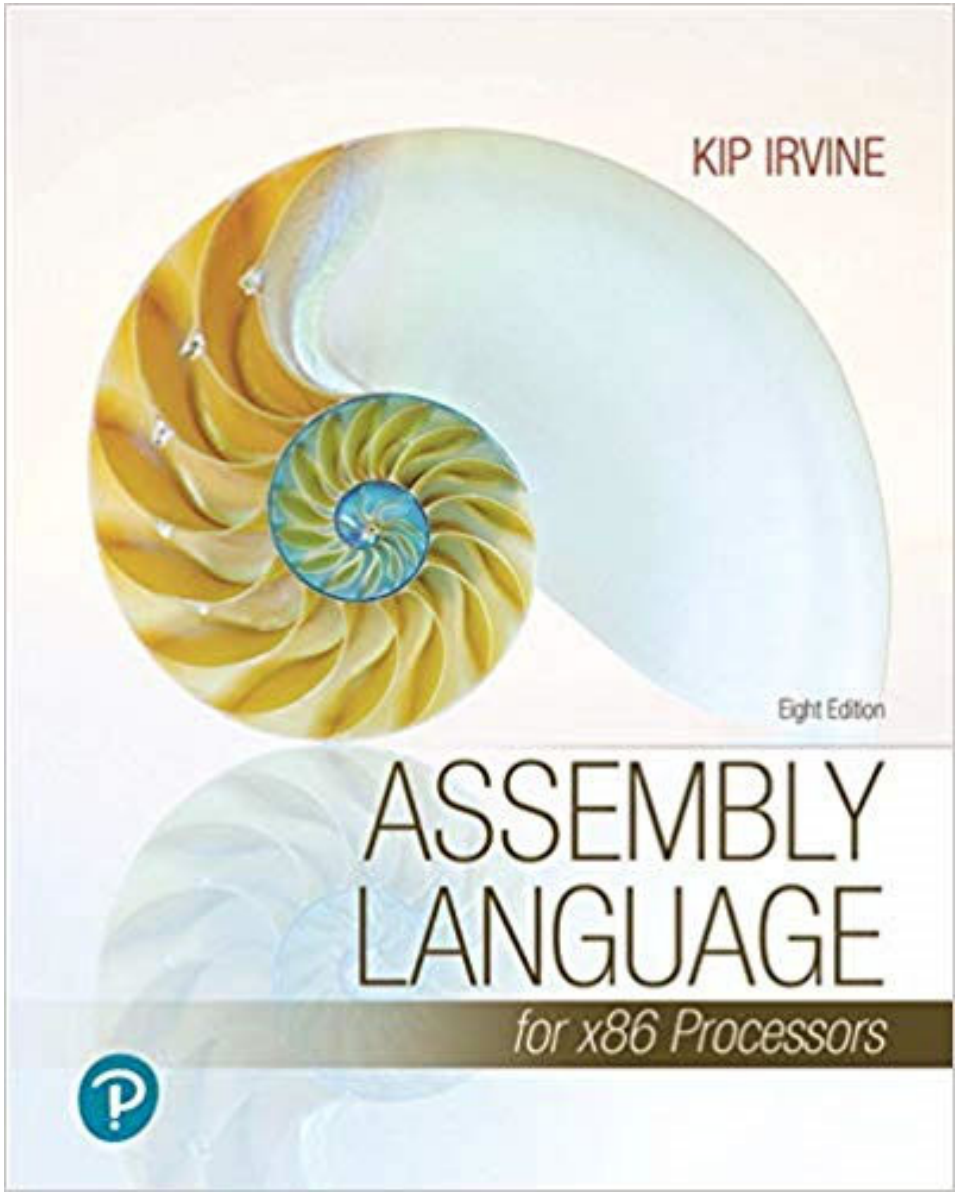
Course Goal

- Give an introduction to computer architecture
  - Data representation: integer, floating-point etc.
  - Boolean algebra and digital logic
  - Hardware organization: CPU, memory, disk etc.
  - Assembly language
- Give a preparation for more advanced courses
  - Operating systems
  - Compiler, Programming Languages
  - Parallel & Distributed Computing

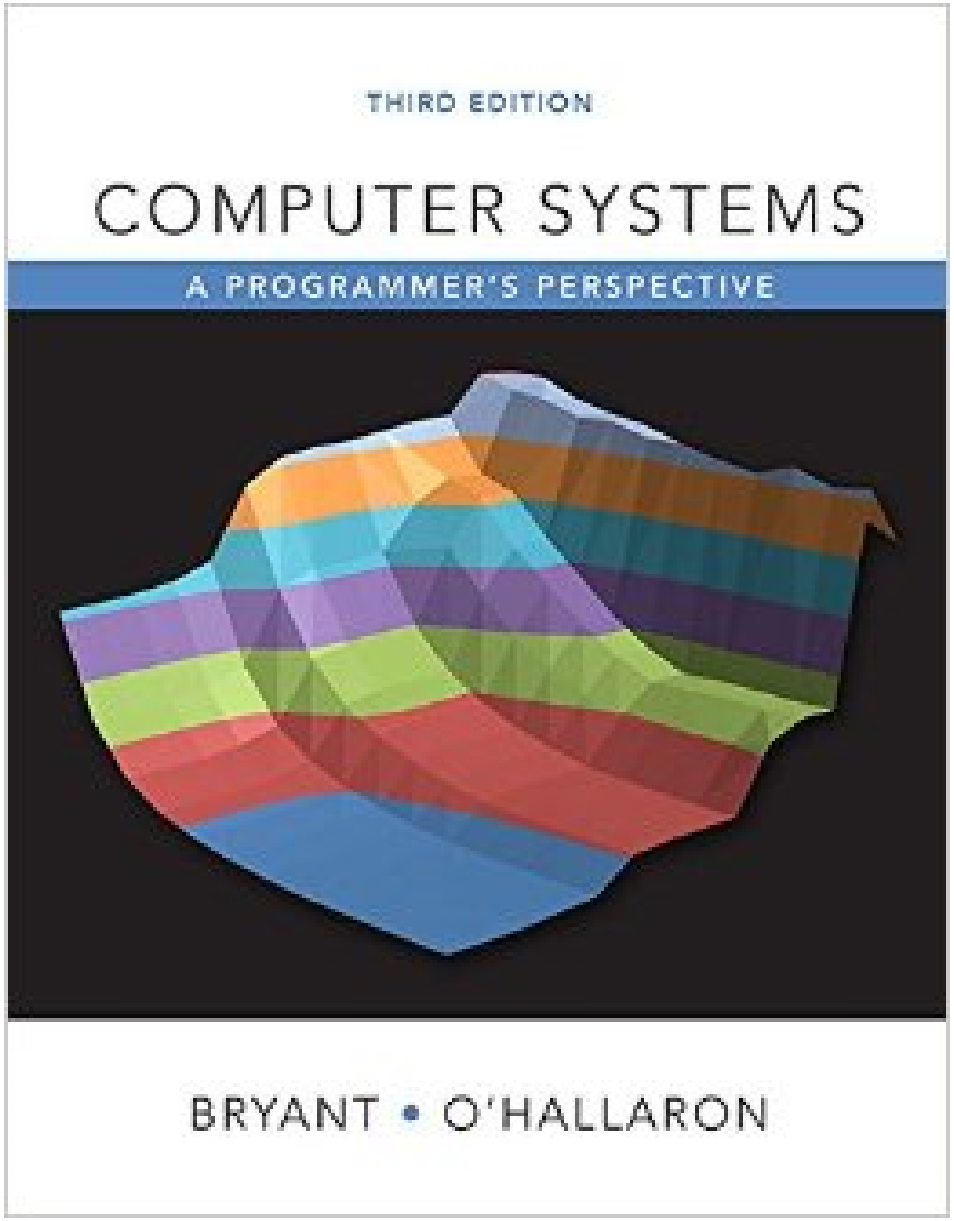
Textbook


THE ESSENTIALS OF
Computer Organization and Architecture
FIFTH EDITION
Linda Null
Julia Lobur
ACCESS CODE INSIDE
NAVIGATE 2
ADVANTAGE ACCESS

Textbook (not required but recommended for the best learning)



Reference Books



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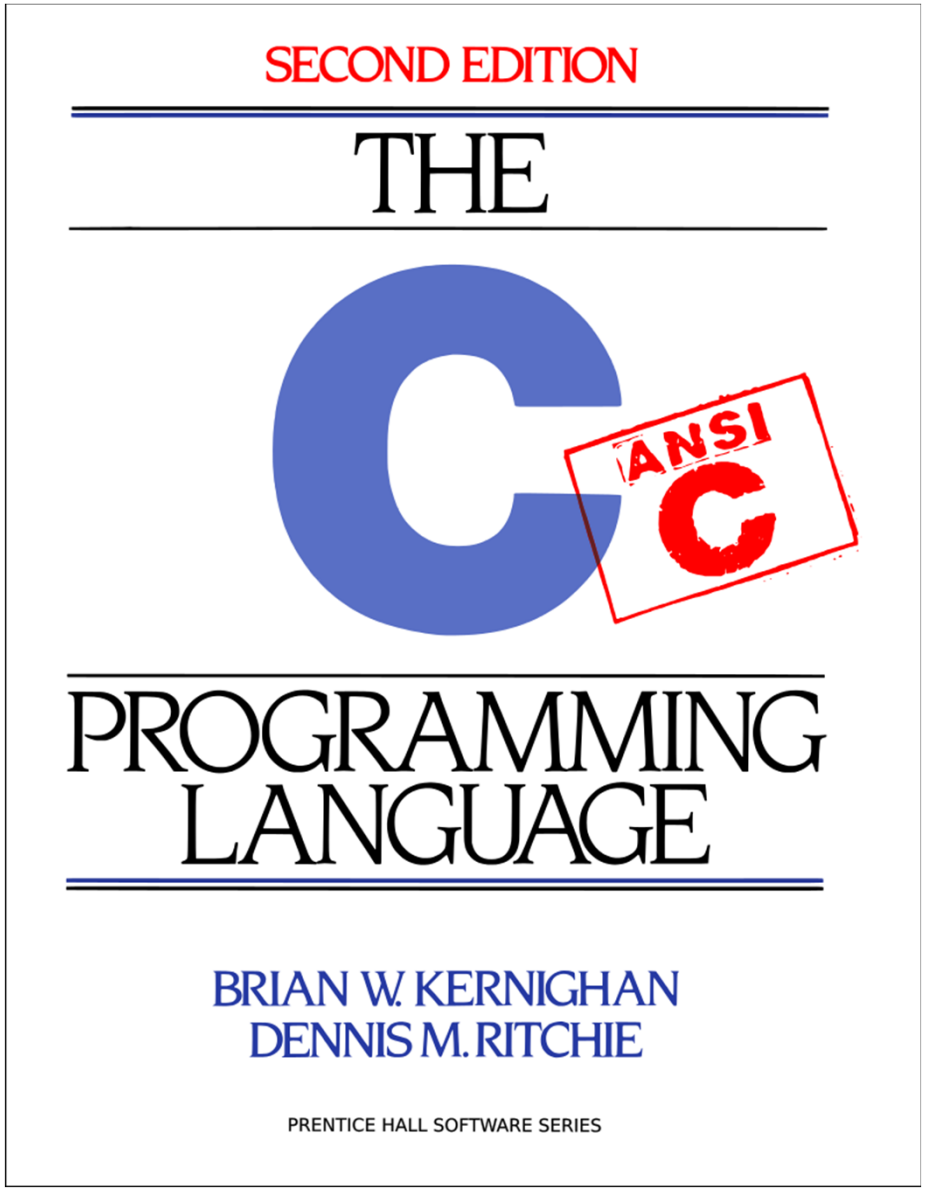

Learning Methodology

- Review course materials in time
- Understand course materials
- Work on all practice problem sets
- Practice! Practice! Practice!
- Don't wait until the last minute!

This course takes time!!!

Different Methods

- Google (or Bing or other search tools)
- Books
- People

I am here to help!

- I see students struggle each semester
- Most of them never ask questions or come to office hours
- I want to help you learn, but I cannot force you to learn
- Better ask for help than linger on and retake the course!

Student Success in CS-3503 COA

Waqas Majeed
CS, CCSE, KSU

Accreditation Metrics

- **ABET accreditation** of KSU BS CS
  - **SO 1**. An ability to apply knowledge of computing and mathematics appropriate to the programs student outcomes and discipline. **> LO2**
  - **SO 2.** An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution. **> LO4**
  - **SO 3.** An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs. **> LO3**

[https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2022-2023]

Textbook:
COA, Null & Lobur, 5e

CS Program Metrics

CS-3503 in KSU BS CS Program

- **LO 1.** Represent data in various formats, and convert between decimal, binary, octal, hexadecimal, sign-magnitude, and ones- and twos-complement. Perform some basic binary arithmetic, multiplication and division. > **Ch2**
- **LO 2.** Use Boolean algebra mathematical expressions and k-maps to describe and manipulate the functions of simple combinational and sequential circuits. Design simple combinational and sequential logic circuits using gates and flip-flops. > **Ch3**
- **LO 3.** Describe and explain the organization of the classical von Neumann computer and its major functional units. Describe the functioning of a single cycle CPU and its internal operations. > **Chs 4&5**
- **LO 4.** Implement basic assembly-language programs. Explain different instruction formats, various addressing modes and how an instruction is executed. > **Ch8**
- **LO 5.** Design simple memory devices and system-level memories. > **Ch6**

Learning Metrics

Activity	Grade Percentage
Attendance + Participation + Videos	2%
Quizzes (4 x 2%)	8%
Midterm Tests (4 x 10%)	40%
Lab Assignments (5 x 10%)	50%

- **CS-3503 Computer Org. & Arch. (2024 Fall)**

Week #	Date	TR (Q-207)	Due (Thursdays)
1	13-Aug	Syllabus & Course Intro, Introduction (chap1)	
2	20-Aug	Data Representation (chap2)	
3	27-Aug		Test-1 (Ch 2)
4	3-Sep	Boolean Algebra & Digital Logic (chap3)	
5	10-Sep		Test-2 (Ch 3)
6	17-Sep	MARIE: An introduction to a simplified computer (chap4)	
7	24-Sep	A closer look at instruction set architecture (chap5)	Lab-1 (MARIE Sim Analysis)
8	1-Oct	Memory (chap6)	
9	8-Oct	Input/output (chap7)	Lab-2 (Memory Design)
10	**15-Oct (*F)**	x86 Processors Assembly Language Programming (Module-8)	Lab-3 (Computer Design)
11	**22-Oct (*F)**		Test-3 (Chs 4, 5)
12	29-Oct	ARM Processors Programming (Module-9)	Lab-4 (x86 Programming)
13	5-Nov		Lab-5a (ARM Setup)
14	12-Nov		Lab-5b (ARM Programming)
15	19-Nov	Advanced Topics	Test-4 (Ch 6, Mod 8)
	26-Nov	Fall Break (Whole-week off)	
Last Class	2-Dec (M)	N/A	
Final Exams	3~9-Dec (T~M)	N/A	
Final Grades	12-Dec (R)	Due at Noon	

I hear, I know. I see, I remember. I do, I understand.
Confucius

Tell me and I forget. Teach me and I remember.
Involve me and I learn.
Benjamin Franklin

Instruction Metrics

- Effectiveness and support in helping learn
  - Stop us; feel free to **ask questions** in class. Happy to answer!
  - Consult **me or the GTA** (multi-day, multiple office hours F2F/Teams).
- Creating learning environment
  - In-class **problem-solving**, and **self-practice** problems sets posted.
  - Small-grade quizzes; **ABET SO-** and CS Program **LO-based** tests.
  - Hands-on individual labs/project for **immersive learning/skills**.
  - Random attendance to promote **active learning** with **flexibility**.
  - Class-participation to encourage **interactive learning**.
- Contents' contribution to student knowledge and skills
  - Problem solving based tests/quizzes for **depth and breadth**.
  - Hands-on labs/project on **industry standard software & hardware**.

CS-3503 COA Course Outlook

- Course Prerequisites (ideally)
  - High-level computer **programming**, Discrete Math., Data Structures
- Course Leads to:
  - **Core:** Operating Systems, Parallel & Distributed Computing, Embedded Systems, Real-time Operating Systems, High-performance Computing, Concepts of Programming Languages, Algorithms, DBs
  - **Electives:** AI, Machine Learning, Big-Data Analytics, Machine Vision, Deep Learning, Robotics, Cyber-/Software/System/Network Security, Compiler Design, System Software, Device Drivers & Firmware Design
- Jobs ($70-150K per annum)
  - Systems Engineer, Device Driver Engineer, Firmware Engineer, Hardware Engineer, Software Engineer, Embedded Systems Engineer, HPC Engineer, ML/DL Engineer, Robotics Engineer to name a few.

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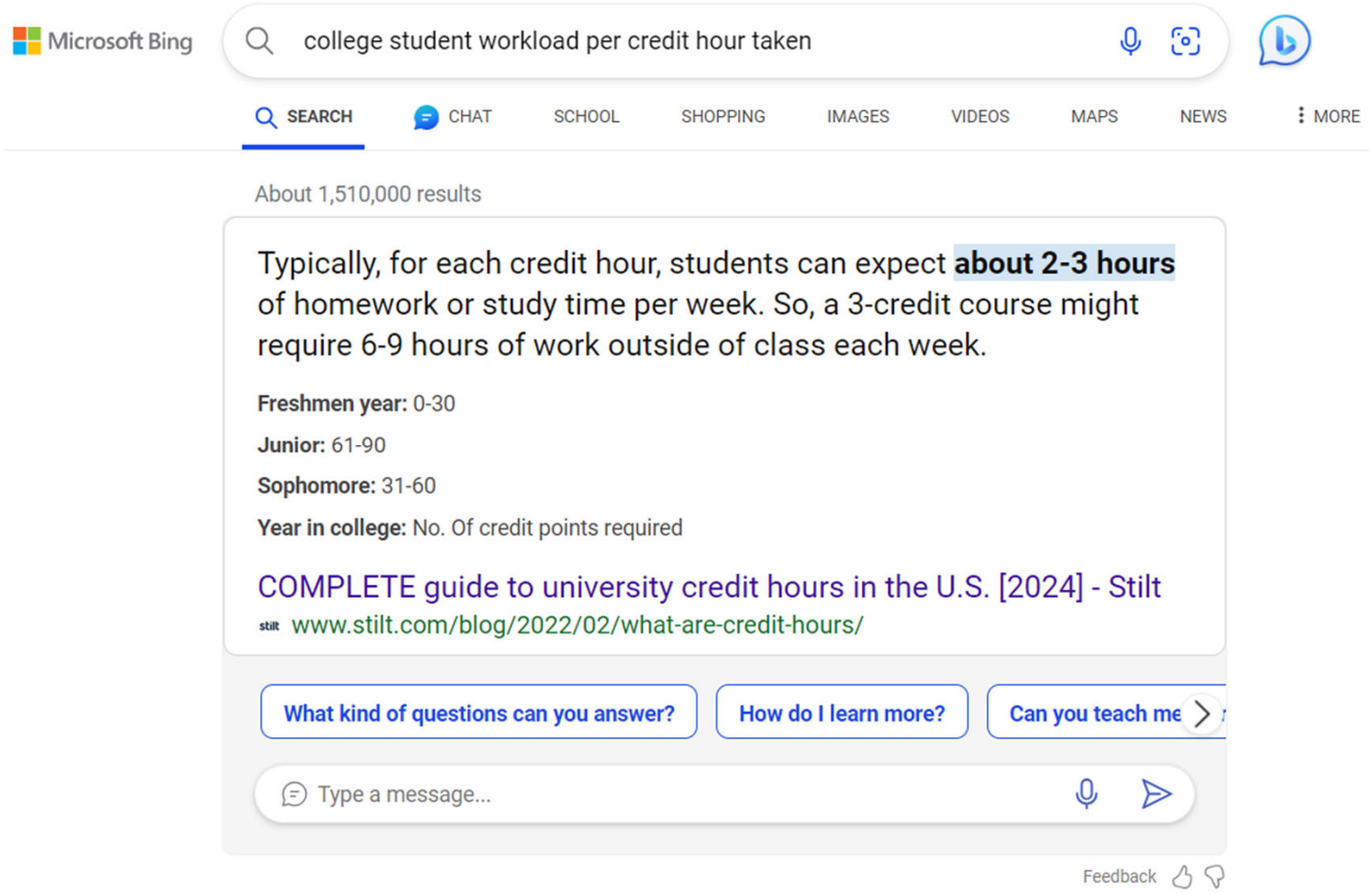
Student Success Tips

- I **respect** and **care** about your success!

- You've paid the tuition (just the start), need to **give time and effort now**!
  - How much Time: 2-3 hours per credit hour (see next slide) → **full workday outside class** for a course.
  - Effort: **Ask questions!**
    - **Attend** all classes, **review** the lecture slides prior and after class, **read** the textbook for deeper and better understanding, **prepare** your own **notes**, **complete and submit** all assignments on time.
    - **Consult GTA and instructor**. Try the best effort on the tests, labs, and project.

- **Take ownership** of your learning, success, and grade!

How much time after class?



Labs/Project

https://os.mbed.com/platforms/ST-Nucleo-F401RE/

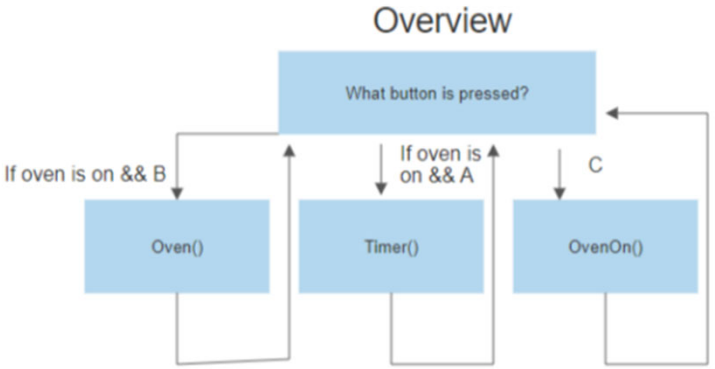
arm MBED | Overview | Hardware | Code | Documentation | Case studies | Community

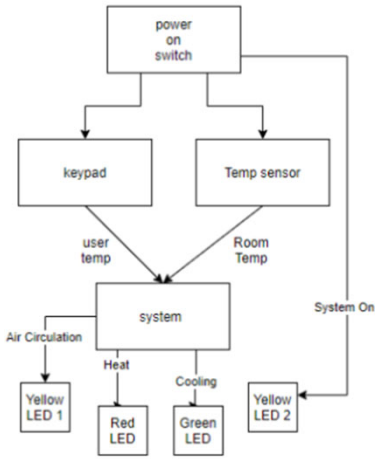
Boards » NUCLEO-F401RE

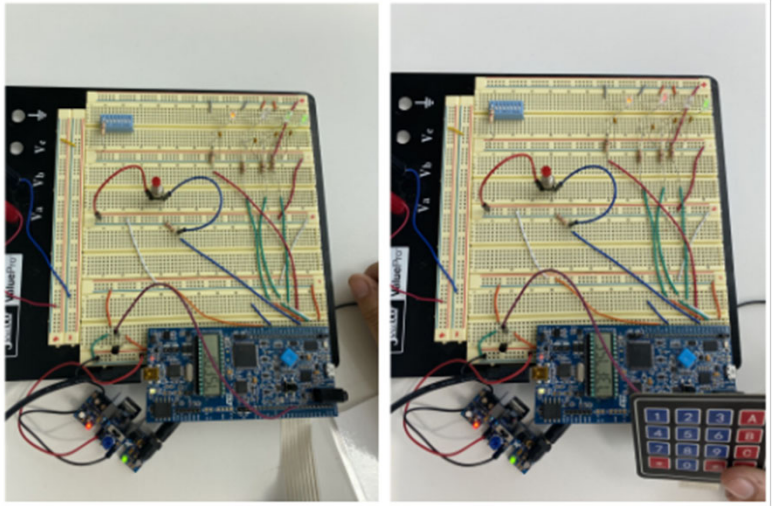
NUCLEO-F401RE

Affordable and flexible platform to ease prototyping using a STM32F401RET6 microcontroller.

Past Student Projects







Questions?

Thank you and have fun!!!