ECE160: Foundations of Computer Engineering I

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ECE Dept., Spring 2023

Welcome to ECE160!

- Today's lecture
  - Course Syllabus & Operational Details
  - Brief History of Computers
  - Background Survey

Course Description

- A course about **C programming language**
- A required course for all CPE and ELE majors in Freshmen level
- 4 credit units (3 hours lecture + 2 hours lab)
- Mode: face-to-face modality

Course Topics

- Computer history
- Number conversions
- Data types
- Variables and assignment statements
- Functions
- Expressions
- If-Else statements and switch statements
- Loops (while, do-while, for, nested for)
- Text files
- Arrays and passing arrays
- Sorting (Bubble sort, Selection sort)
- Strings and pointers

This is a tentative topic outline that is subject to changes based on class performance and exceptional cases

Course Objectives & Learning Outcomes

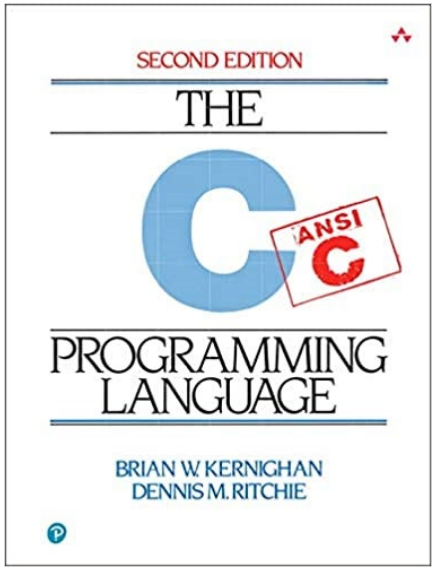
Upon **successfully** completing this course, you will be able to learn

- How a computer stores data, and conversion between various number bases
- The fundamentals of using the C compiler and C preprocessor
- How to use a modern environment to create, compile, execute, debug C programs
- How to use procedures to modularize a program, and how to pass parameters by value and by reference
- The syntax of the C language, including arrays, structures, and file access
- How to use and manipulate strings using the C language.
- How to use system libraries within a program
- How to program, and how to design well-written, maintainable programs

Resources

Resources (1)

- **Lecture notes** prepared by Prof. Xing, available from the class website
- **Textbook**
  - The C Programming Language (Second Edition), by B. W. Kernighan and D. M. Ritchie, Publisher: Prentice Hall



"…the holy book for C programmers of all skill levels and accepted as one of the best books to learn C programming" *https://hackr.io/blog/10-best-c-cpp-books*

"The C Programming Language — it should be renamed to "The C Programmer's bible". This book is a must-have for any C programmer." *commented by Marty Jacobs*

Resources (2)

- **References**
  - Let Us C (8th Ed.), by Y. P. Kanetkar, Infinity Science Press, 2008
  - C How to Program (4th Ed.), by *H. M. Deitel* and *P. J. Deitel*, ISBN: 0131426443, Publisher: Prentice Hall
  - C Programming for Engineering and Computer Science (B.E.S.T. Series) by *H. H. Tan* and *T. B. D'Orazio*, Publisher: McGraw-Hill Companies
  - An Introduction to the C Programming Language and Software Design, by Tim Bailey; http://www-personal.acfr.usyd.edu.au/tbailey/ctext/ctext.pdf
  - C Language Tutorial, by Gordon Dodrill; https://phy.ntnu.edu.tw/~cchen/ctutor.pdf

Course Website

- https://xing160.sites.umassd.edu/
  - News and announcements (*Recent Posts*)
  - Syllabus
  - Major deadlines and other critical dates
  - Homework assignments
  - Lab assignments
  - Lecture notes
  - Exams
  - Frequently asked questions on assignments, exams
  - Check ***frequently!***

Course Requirements

Homework Assignments

- Homework are always due by the beginning of class on the due date.
- Complete all homework assignments on time.
- Assignments one day late subtract 10%; two days late loses 25%; three days late loses 50%. After 3 days the assignments will be considered a ZERO. This penalty rule will be strictly enforced, except for some exceptional cases (**You must inform the instructor ahead of time**!)
- Keep each assignment for helping you prepare for the exams

Lab Assignments

- Lab assignments are always assigned on Monday and due by **5pm on Wednesday**.
- Complete all lab assignments on time.
- Unless you have a legitimate reason and inform the instructor or TA in advance, late lab assignments will not be accepted.
- Keep each lab assignment for helping you prepare for the exams

Homework -- Working Together

- Homework assignments are designed to facilitate your learning of the concepts. It is important that you understand the solutions to all assigned problems, and the best way to gain an understanding is to work them out and write them up by yourself. However, there are occasions when outside help can be beneficial. Hence **the policy for homework**:

You are free to talk to others about the problems at your discretion (though I strongly suggest you do this only when you are completely stuck), but you may not leave a discussion with any type of record or notes pertaining to the discussion. If you can recall the solution from memory, you probably understand it. The actual write-up must be done entirely by yourself!

Lab Exercises – Individual Work

- You may not work together with another classmate in doing the lab assignments/programming.
- But you feel free to seek help from TA or instructor.

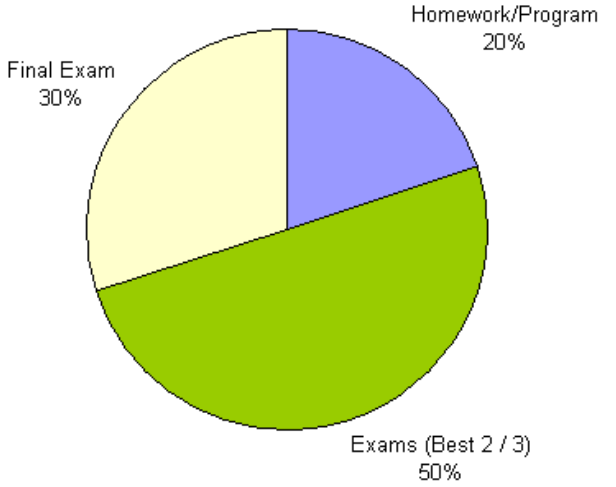
Exams

- **There will be 3 midterm exams and a final exam**
  - Midterm exams tentative dates: **Feb. 17; Mar. 24; Apr. 21**
  - Final exam: **May 1 (Mon.) 8am ~ 11am**
  - No make-ups! No early/late-taken exams unless absence is excused by your advisor
  - There will be a 'review session' prior to each exam
  - **Best 2 out of 3 midterm exams & the final exam** are counted toward your final grade
- **All exams in this class are definitely an individual endeavor!** You may not work together during exams. You may not share any materials during an exam. In general, the penalty for cheating on an exam or otherwise covertly attempting to raise your grade on an exam shall be a 'ZERO' for the exam.

For more details on academic integrity, refer to Student Handbook:

https://www.umassd.edu/studentaffairs/studenthandbook/academic-regulations-and-procedures/

Grading Policy



- **Homework/Lab: 20%**
- **Midterm Exams (Best 2 out of 3): 50%**
- **Final Exam: 30%**

The letter grades will be assigned using the following approximate scale:
(A+, A) [100-90] (A-, B+, B) (90-80] (B-, C+, C) (80-70]
(C-, D+, D) (70-60] (D-) (60-57] (F) [60-0]

UMass Dartmouth grading system:
https://catalog.umassd.edu/content.php?catoid=62&navoid=5015#Grades_and_Grading_System

Class Attendance Policy

- Students are expected to regularly attend classes
- The instructor reserves the right to record attendance from time to time (not regularly).
- Students who miss a lecture must self-study the missed material (available from the course website) and make arrangement with the instructor about any questions of the missed lecture when necessary.

Lab Attendance Policy

- Students are encouraged to do the lab assignments during their enrolled lab sessions, where the instructor and TA are available to answer questions.
  - L1: Monday 10-11:50am
  - L2: Wednesday 10-11:50am
- However, you may complete the lab assignments outside the regular lab session time and do the submission of the lab results by the deadline (**5pm on Wednesday**).

The first lab starts in the week of January 23!

Cancelled Classes and Exams

- If class is cancelled on the day an exam is scheduled, we will have the exam the next time the class meets.

- If class is cancelled for the session prior to the exam (the day for review and for asking questions), then the next class meeting will be the "review session", and the exam will take place in the class meeting after that.

COVID-19 Management Policy

- Please follow the health and safety protocols when you come to the campus: https://www.umassd.edu/covid/
- If you test positive for COVID-19, please refer to:

  https://www.umassd.edu/covid/
- For students who become ill or are required to isolate, please contact me asap; I will respond with information about my expectations for completion of course materials.
- If I test positive but my conditions allow, I will deliver lectures online using Zoom during the isolation; if my conditions require class cancellation or other changes for this course, I will send an email about alternative arrangements to the umassd.edu email account of all class members.

Incomplete Grade Policy

- The incomplete policy for this course is that at least 70% of the course must be already completed and an exceptional circumstance (e.g., medical issue) must exist.
- If you feel you require an incomplete for an exceptional reason, you need to email me and state your reasons for the incomplete in writing. We will then decide on a course of action.

Important Advice

- Please attend every class (much of the material builds on itself sequentially, so missing a class will diminish your ability to follow the subsequent material).
- Please come to class prepared; the lectures and in-class hands-on problems will be more beneficial if you complete the assigned reading text before arriving at class.
- Please do not fall behind or procrastinate; "cramming" won't work in this class!
- Please feel free to ask questions at any time; I am here to help you.
- Please feel free to send any comments and feedbacks on how to improve lectures. If you have any interesting experiences on how to solve problems or do well in the class, please feel free to let me know too, so that we can share your tips with your classmates.

In Case of Trouble

If you feel yourself slipping behind, feel free to meet the instructor for advice. If you do decide the class is not happening for you at this semester,

- the last day to Add/Drop is **Tuesday, January 24**, and
- the last day to Withdraw is **Friday, April 7**.

However, before you withdraw, discuss your decision with the instructor and your academic advisor.

In Case of Special Needs

- Please feel free to contact the instructor if you have any special needs that require accommodation.

- Particularly, if you or a family member become sick that affects your submission of an assignment or participation in an exam, please feel free to email me to request an extension to complete the assignment without late penalty or alternative arrangements for the exam.

Academic Support Services

- Engineering Student Support & Services (ES3) (https://www.umassd.edu/engineering/support/)
- Academic Resource Center (www.umassd.edu/arc/)
- STEM Learning Lab (https://www.umassd.edu/arc/stemlearning-lab/)
- Center for Access and Success (www.umassd.edu/dss/)
- Writing &Multiliteracy Center (www.umassd.edu/wmc/)

Title IX Information

- The purpose of a university is to disseminate information, as well as to explore a universe of ideas, to encourage diverse perspectives and robust expression, and to foster the development of critical and analytical thinking skills. In many classes, including this one, students and faculty examine and analyze challenging and controversial topics.
- If a topic covered in this class triggers post-traumatic stress or other emotional distress, please discuss the matter with the professor or seek out confidential resources available from the Counseling Center, http://www.umassd.edu/counselling/, 508-999-8648 or - 8650, or the Victim Advocate in the Center for Women, Gender and Sexuality, http://www.umassd.edu/sexualviolence/, 508-910-4584.
- In an emergency contact the Department of Public Safety at 508-999-9191 24 hrs./day.

Contacting Instructor (1)

- Instructor contact information
  - Email: **lxing@umassd.edu**
  - **Office Hours (In-person @ SENG213C)**
    - Mon. 3:30pm – 4:30pm
    - Wed. 3:30pm – 4:30pm
    - Fri. 10:00am – 12:00pm
    - Or other time by appointment via email.

Contacting Instructor (2)

- Please feel free to contact the instructor if you have any
  - special needs
  - questions about assignments or exams
  - comments, feedbacks on how to improve lectures
  - interesting experiences or tips on how to do well in the class

- Constructive criticism will be appreciated; you may use the following Yahoo email account to send your anonymous feedback to lxing@umassd.edu
  - ID: feedback02747@yahoo.com
  - PWD: feedback4xing

Communication Plan

- Please check the class website frequently (https://xing160.sites.umassd.edu/), the *Recent Posts* section will be used as a primary means of notification of new assignments, deadlines, any class related announcements and information.

- Other than questions asking and answering during the specified office hours, you may also email me with your questions. You can expect a reply from me via email within 24 hours during the workweek.
- If the question a student asked is of a nature that even one other student in the course could benefit from the answer, the question and the answer will be posted in the FAQ section of the course website.

Enjoy the class!

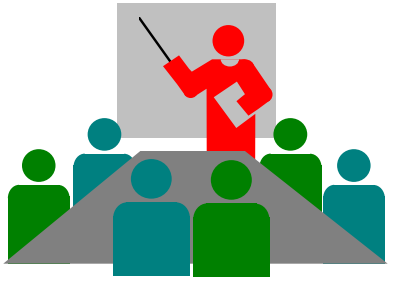
Have A

Fruitful & Joyful

Semester!

Welcome to ECE160!

- Today's lecture
  - Course Syllabus & Operational Details
  - **Brief history of computers**
  - Background Survey



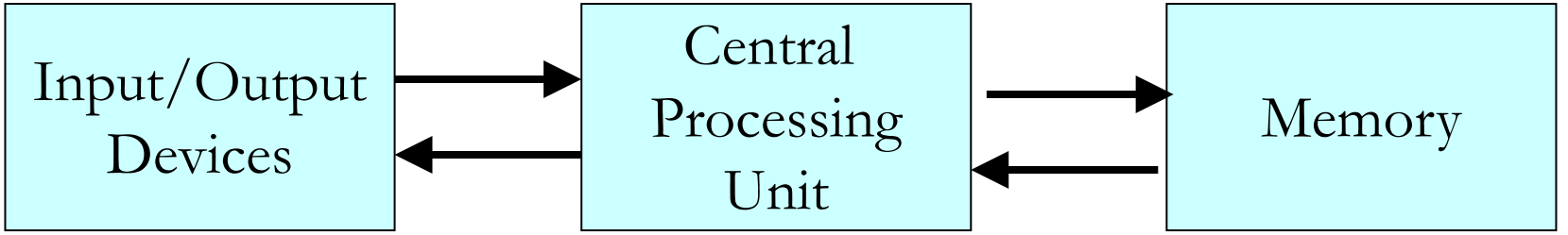
What defines a modern computer?

Definition of Modern Computer

- A computer is an electronic machine that
  - takes in data and instructions (input)
  - works with the data (processing)
  - puts out information (output)

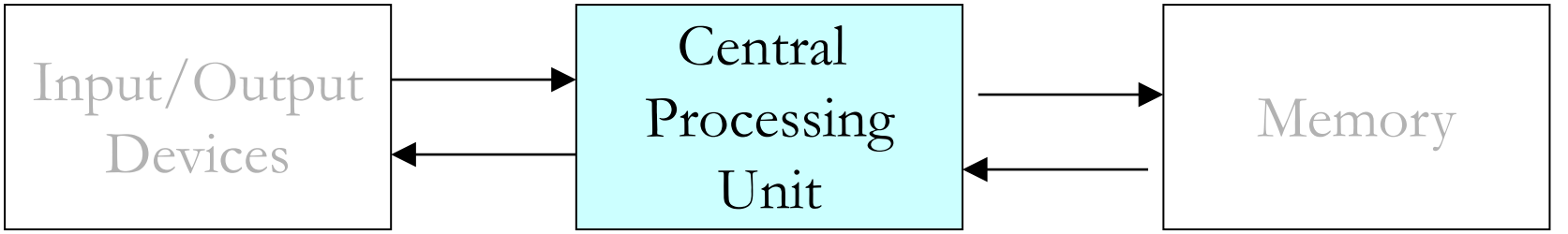
- Computers are made of HARDWARE (physical equipment) and SOFTWARE (the instructions that tell the computer what to do: system software and application software)

Hardware Components of a Typical Computer



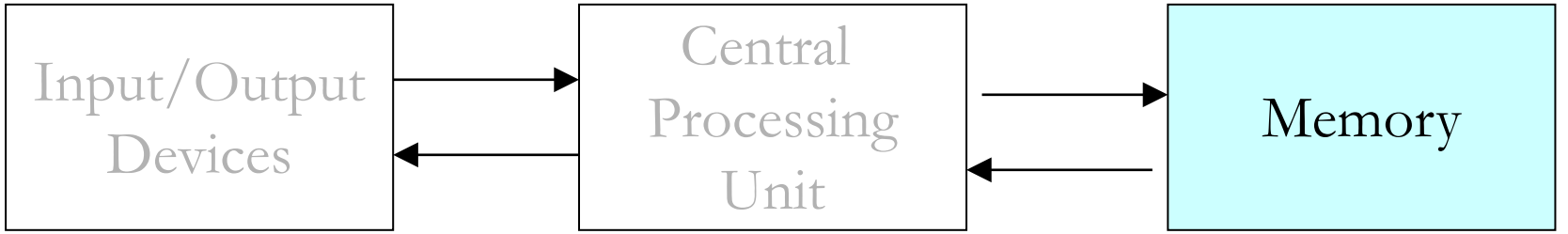
"Buses" allow components to pass data to each other.

Central Processing Unit (CPU)



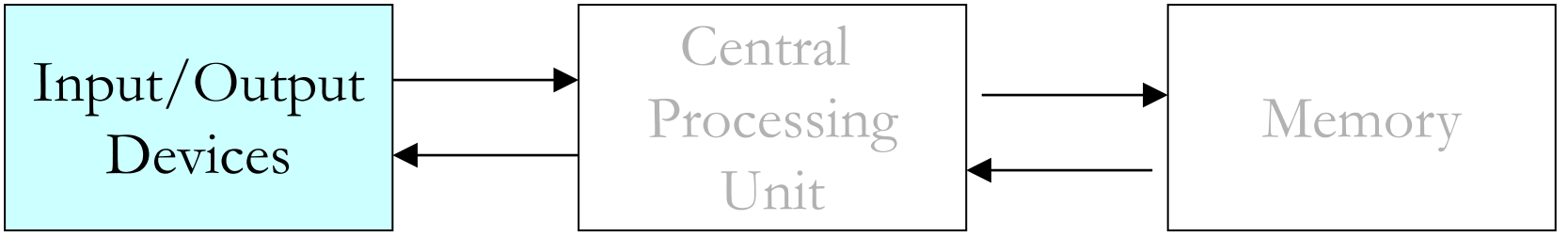
- Performs the basic operations
- CPU consists of two parts:
  - Arithmetic and Logic Unit (**ALU**) - data manipulation
  - Control Unit - coordinate machine's activities

Main Memory



- Holds programs and data
- Stores bits in fixed-sized chunks:
  - "word" (8, 16, 32, or 64 bits)
- Each word is stored in a cell, which has a unique address

I/O Devices (Peripherals)



- To communicate with the outside world.
- Examples:
  - **Input:** keyboard, mouse, microphone, scanner, etc.
  - **Output:** printers, monitors, audio speakers, etc.

How about the computers in early days?

History of Computers – Computer Generations

Generation	Approximate Dates	Technology	Typical Speed (operations per second)
1	1946–1957	Vacuum tube	40,000
2	1958–1964	Transistor	200,000
3	1965–1971	Small and medium scale integration	1,000,000
4	1972–1977	Large scale integration	10,000,000
5	1978–1991	Very large scale integration	100,000,000
6	1991-	Ultra large scale integration	1,000,000,000

W. Stallings, "Computer Organization and Architecture: Designing for Performance (9th Ed.)", Table 2.2

The 1st Generation

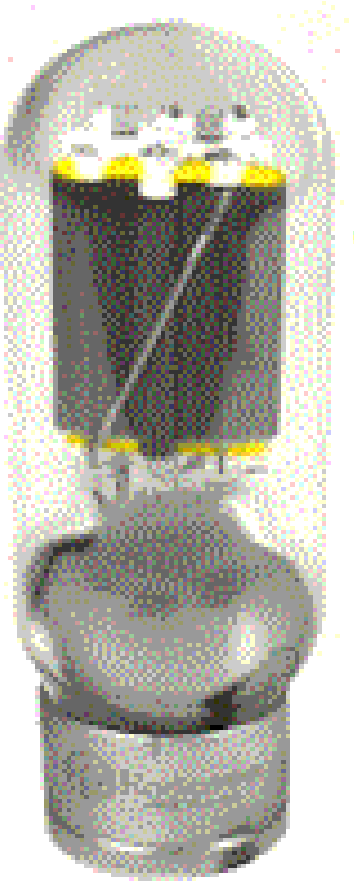
Vacuum Tubes

(1946-1957)

Vacuum Tubes

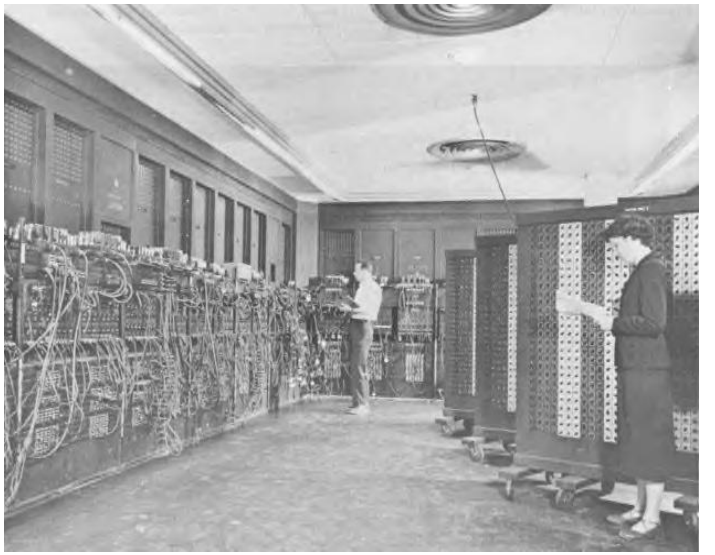
- Vacuum tubes are glass tubes with circuits inside.
- Vacuum tubes have no air inside of them, which protects the circuitry.

http://en.wikipedia.org/wiki/Vacuum_tube



ENIAC (Electronic Numerical Integrator And Computer)

- First general-purpose electronic digital computer
- designed by *Mauchly* & *Eckert* at the University of Pennsylvania
- started 1943, finished 1946
- disassembled 1955
- 18,000 vacuum tubes
- 30 tons
- 30 feet × 50 feet
- 140 kw power consumption
- 5000 additions per second
- Data was entered on punched cards
- Entering & altering programs was extremely tedious
  - programmed manually by setting switches and plugging & unplugging cables
  - programming for typical calculations required from 1/2 hour to a whole day



Stored-Program Concept

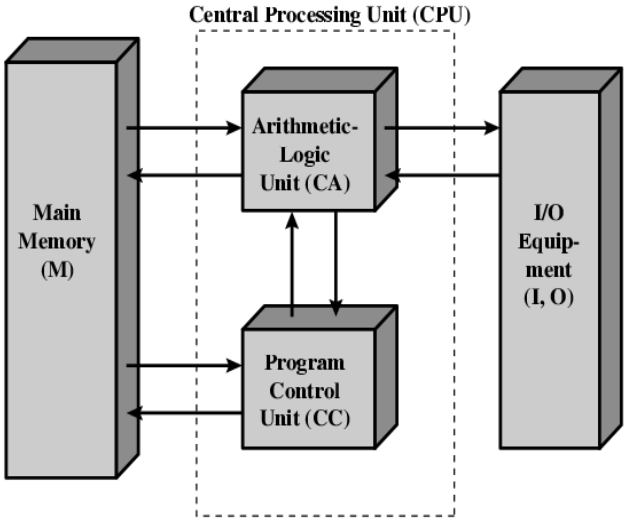
Programming could be facilitated if program could be represented in a form suitable for storing in memory alongside the data. Then a computer could get its instructions by reading from memory, and a program could be set or modified by setting the values of a portion of memory

- Proposed by *Von Neumann* in 1945
- Developed by *Turing* about the same time
- Applied to IAS computer by Von Neumann et al.

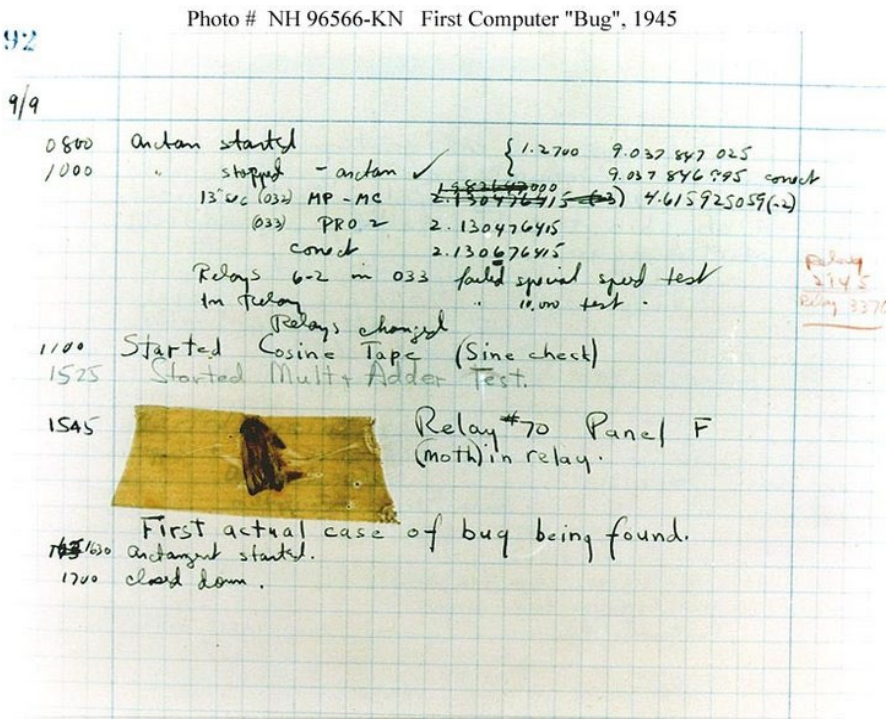
IAS Computer

- Named for the **I**nstitute for **A**dvanced **S**tudy at Princeton University
- Began 1946, completed 1952
- The prototype of all subsequent general-purpose computers
- Structure

- Von Neumann machines



First Computer Bug - 1945



- Grace Hopper found a moth stuck in a relay responsible for a malfunction
- Called it "**debugging**" a computer

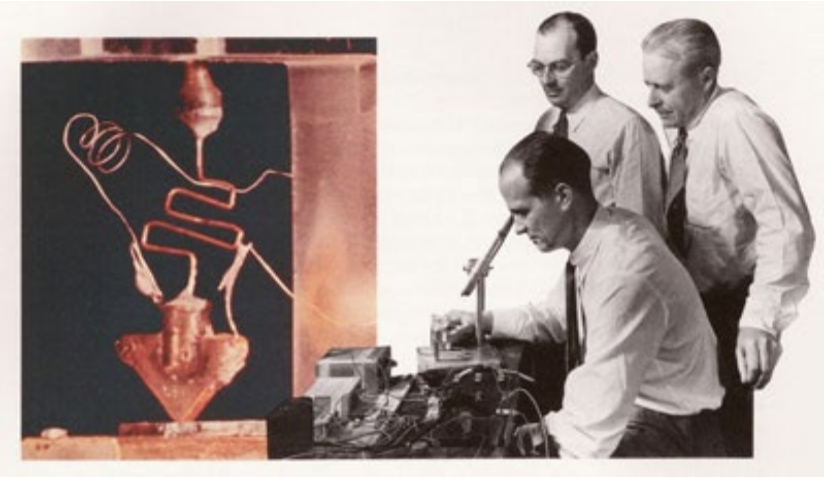
A computer bug: an error, flaw, mistake, failure, or fault in a computer program that prevents it from working correctly or produces an incorrect result. (*http://en.wikipedia.org/wiki/*)

The 2nd Generation

Transistor

(1958-1964)

First Transistor



http://www.cedmagic.com/history/transistor-1947.html
William Shockley (seated at Brattain's laboratory bench), John Bardeen (left) and Walter Brattain (right)

- Invented at Bell labs in 1947
- Won a Nobel prize
- Uses Silicon

http://en.wikipedia.org/wiki/Transistor

Transistor-Based Computers

- **N**ational **C**ash **R**egister & **R**adio **C**ompany of **A**merica (NCR & RCA, front-runners)
- IBM (IBM 7000 series)
- **D**igital **E**quipment **C**orporation (DEC, 1957, PDP-1)

The 3rd + Generation

Integrated Circuits (Chips)
(1965 – Present)

First Chip

- Invented by Jack Kilby at Texas Instruments in 1958
- Integrated Circuits are transistors, resistors, and capacitors integrated together into a single "chip"
- Won a Nobel prize

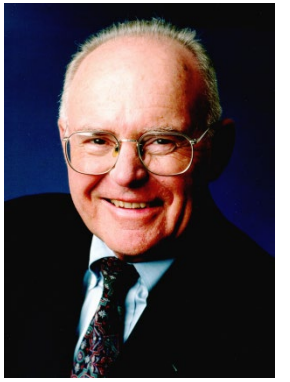
3rd+ Generation - Integrated Circuits

- **S**mall-**S**cale **I**ntegration (SSI, 1965 on)
  - up to 100 devices/chip,
- **M**edium-**S**cale **I**ntegration (MSI, to 1971)
  - 100 - 3,000 devices/chip,
- **L**arge-**S**cale **I**ntegration (LSI, 1972-1977)
  - 3,000 - 100,000 devices/chip,
- **V**ery **L**arge-**S**cale **I**ntegration (VLSI, 1978 – 1991)
  - 100,000 - 1,000,000 devices/chip,
- **U**ltra **L**arge-**S**cale **I**ntegration (ULSI, 1991 - present)
  - More than 1 million devices /chip

Moore's Law

- Number of transistors on a chip will double every year - by Gordon Moore, Intel cofounder in 1965
- The pace slowed to a doubling every 18 months and sustained ever since 1970s

Moore's Law (Cont'd)



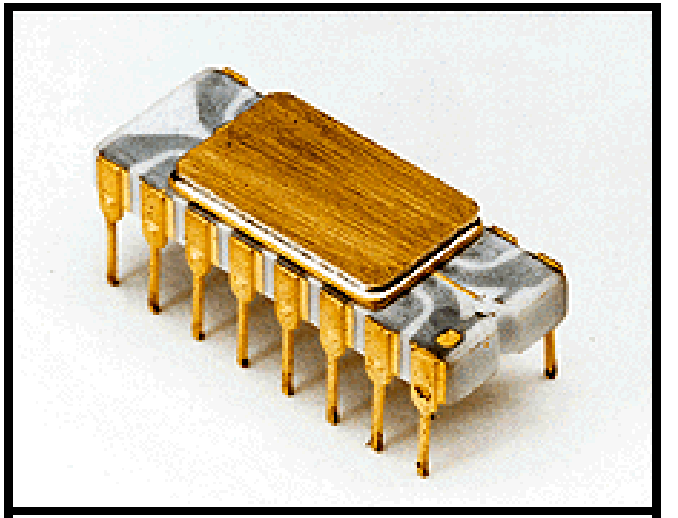
- How long will Moore's Law hold?
  - Moore (1997): It'll go for at least a few more generations of technology. Then, in about a decade, we're going to see a distinct slowing in the rate at which the doubling occurs. I haven't tried to estimate what the rate will be, but it might be half as fast **- three years instead of eighteen months**.

Intel's CEO, Brian Krzanich, said the company would "strive to get back to two years" for innovation to keep Moore's Law on track. *From "The Conversation" July 2015*

The First Microprocessor – 1971

- The Intel 4004 had 2,250 transistors
- four-bit
- 108Khz
- Called "Microchip"

The Pioneer 10 spacecraft used the 4004 microprocessor. It was launched on March 2, 1972 and was the first spacecraft and microprocessor to enter the Asteroid Belt.



The Intel 4004, it was supposed to be the brains of a calculator. Instead, it turned into a general-purpose microprocessor as powerful as ENIAC.

Evolution Characteristics

- Increasing processor speed
- Decreasing component size
- Increasing memory size
- Increasing I/O capacity and speed

Table 2.6 Evolution of Intel Microprocessors (page 1 of 2)

(a) 1970s Processors

	4004	8008	8080	8086	8088
Introduced	1971	1972	1974	1978	1979
Clock speeds	108 kHz	108 kHz	2 MHz	5 MHz, 8 MHz, 10 MHz	5 MHz, 8 MHz
Bus width	4 bits	8 bits	8 bits	16 bits	8 bits
Number of transistors	2,300	3,500	6,000	29,000	29,000
Feature size (μm)	10		6	3	6
Addressable memory	640 Bytes	16 KB	64 KB	1 MB	1 MB

(b) 1980s Processors

	80286	386TM DX	386TM SX	486TM DX CPU
Introduced	1982	1985	1988	1989
Clock speeds	6 MHz - 12.5 MHz	16 MHz - 33 MHz	16 MHz - 33 MHz	25 MHz - 50 MHz
Bus width	16 bits	32 bits	16 bits	32 bits
Number of transistors	134,000	275,000	275,000	1.2 million
Feature size (μm)	1.5	1	1	0.8 - 1
Addressable memory	16 MB	4 GB	16 MB	4 GB
Virtual memory	1 GB	64 TB	64 TB	64 TB
Cache	—	—	—	8 kB

W. Stallings, "Computer Organization and Architecture: Designing for Performance (9th Ed.)"

Table 2.6 Evolution of Intel Microprocessors (page 2 of 2)

(c) 1990s Processors

	486TM SX	Pentium	Pentium Pro	Pentium II
Introduced	1991	1993	1995	1997
Clock speeds	16 MHz - 33 MHz	60 MHz - 166 MHz,	150 MHz - 200 MHz	200 MHz - 300 MHz
Bus width	32 bits	32 bits	64 bits	64 bits
Number of transistors	1.185 million	3.1 million	5.5 million	7.5 million
Feature size (μm)	1	0.8	0.6	0.35
Addressable memory	4 GB	4 GB	64 GB	64 GB
Virtual memory	64 TB	64 TB	64 TB	64 TB
Cache	8 kB	8 kB	512 kB L1 and 1 MB L2	512 kB L2

(d) Recent Processors

	Pentium III	Pentium 4	Core 2 Duo	Core 2 Quad
Introduced	1999	2000	2006	2008
Clock speeds	450 - 660 MHz	1.3 - 1.8 GHz	1.06 - 1.2 GHz	3 GHz
Bus sidth	64 bits	64 bits	64 bits	64 bits
Number of transistors	9.5 million	42 million	167 million	820 million
Feature size (nm)	250	180	65	45
Addressable memory	64 GB	64 GB	64 GB	64 GB
Virtual memory	64 TB	64 TB	64 TB	64 TB
Cache	512 kB L2	256 kB L2	2 MB L2	6 MB L2

Welcome to ECE160!

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  - Brief history of computers
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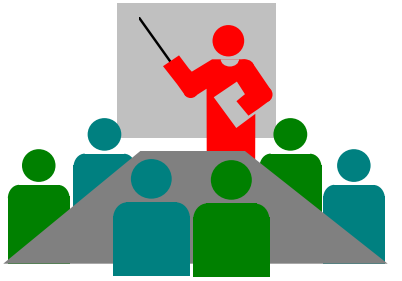

Things To Do

- Review the course syllabus
- Check out the class website

https://xing160.sites.umassd.edu/

Next Topic

- Number systems

Welcome Again to ECE160 Class!