CEG 2136
Computer Architecture 1

INTRODUCTION

Computer Architecture 1

CEG 2136 Computer Architecture I (3,0,3b) 3 cr.

Design a digital computer to execute a given instruction set. Design of digital computers. Register transfer and micro-operations. Designing the instruction set, CPU and CPU control. Basic machine language programming. Using pipelines for CPU design. Designing the memory unit. Designing Input- Output subsystem.

.

Professor :

Dr. Fadi Malek
Email: malek@uottawa.ca

LEC 1	**Tuesday 14:30 - 16:00**	**MNT 203**
LEC 2	Friday 16:00 - 17:30	MNT 203
DGD1	Tuesday 16:00 - 17:30	FTX 227
DGD2	Friday 13:00 - 14:30	MNT 207
DGD3	Wednesday 19:00 - 20:30	VNR 2095
LAB 1	Monday 08:30 - 11:30	CBY B302
LAB 2	Thursday 19:00 - 22:00	CBY B302
LAB 3	Wednesday 11:30 -14:30	CBY B402

Textbook (REQUIRED)

Available at the University of Ottawa bookstore.

Book Title :	**Computer System Architecture**
Authors	**: M. Morris Mano**
Edition	**: Third Edition**
Publisher	**: Pearson-Prentice Hall Textbook**

Grading Scheme

Quizzes / Midterm	30%
Laboratories	20%
Final Exam	50%

Mid-term exam date:

Date/Time: TBD

Location: TBD

Course Web Site: On Virtual Campus (BrightSpace).

- Go to http://uottawa.brightspace.com.
- Enter your uoAccess ID and password in the appropriate cells and click on "Login".
- Click on CEG 2136 to access the course web site

.

Laboratory

Lab Manual: *CEG 2136Laboratory Manual* (PDF file on the Course Web site)

-Each student will have a laboratory session every week. There are **4** to be performed, each requiring a group preparation and completed report.

-Laboratory groups will consist of **MAX THREE students only.**

-Students are required to **stay in the same group** for the entire semester.

-Laboratory rules and regulations will be posted on the course web site.

-Four (4) laboratories are to be completed. You must work in groups of two for the entire term. A lab report is expected by each group for each laboratory. The report must be prepared according to the directions that are found in the laboratory manual. The report must be submitted electronically (in WORD);

-The lab report should be prepared according to the guidelines specified in the **lab instructions**.

Assignments:

There will be 3 assignments for this course. Assignments are not graded. They are practice questions.

Quizzes:

There will be unannounced quizzes for this course on random dates.

Cheating and plagiarism

- **Cheating** is any act that gives you unfair advantage at the expense of another classmate.
  Examples: copying on exams, homework , lab reports
- **Plagiarism (READ the following URL: http://www.uottawa.ca/plagiarism.pdf)**
- If we detect you are involved in cheating or plagiarism,
  you will be turned over to the Faculty, for investigation and sanctions.

Course Outline

1. Digital Logic Circuits
2. Digital Components
3. Data Representation
4. Register Transfer and Micro-operations
5. Basic Computer Organization and Design
6. Programming the Basic Computer

What Is Computer Architecture?

Computer Architecture =

Instruction Set Architecture + Machine Organization

Instruction Set Architecture

- Defines the supported instructions and data types
- Instructions are used to control a computer's central processing unit (CPU)
- Each instruction causes the CPU to perform a very specific task, such as a load, a store, etc

Machine Organization

- Capabilities & performance characteristics of principal functional units (e.g., registers, ALU, shifters, logic units)
- Ways in which these components are interconnected
- Information flow between components
- Logic and means by which such information flow is controlled

What is “Computer”

- **A computer is a machine that performs computational tasks using stored instructions.**

A computer consist of … ?

1) Central processing unit (CPU);

2) Random access memory (RAM);

3) Input-output processors (IOP).

- **These devices communicate to each other through a set of electric wires called bus.**

CPU consists of

- **> Arithmetic logic unit (ALU): Executes arithmetic (addition, multiplication,...) and logical (AND, OR,...) operations.**
- **> Control unit: Generates a sequence of control signals (cf. traffic signal) telling the ALU how to operate; reads and executes microprograms stored in a read only memory (ROM).**
- **> Registers: Fast, small memory for temporary storage during mathematical operations.**

RAM stores

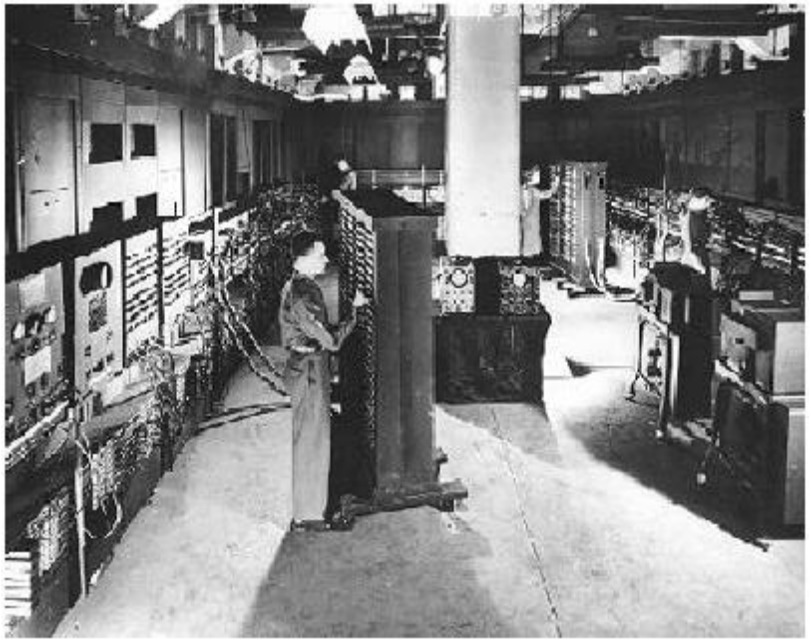
- **> Program: A sequence of instructions to be executed by the computer**

- **➢ Data**

Brief History of Computers

History of Computers

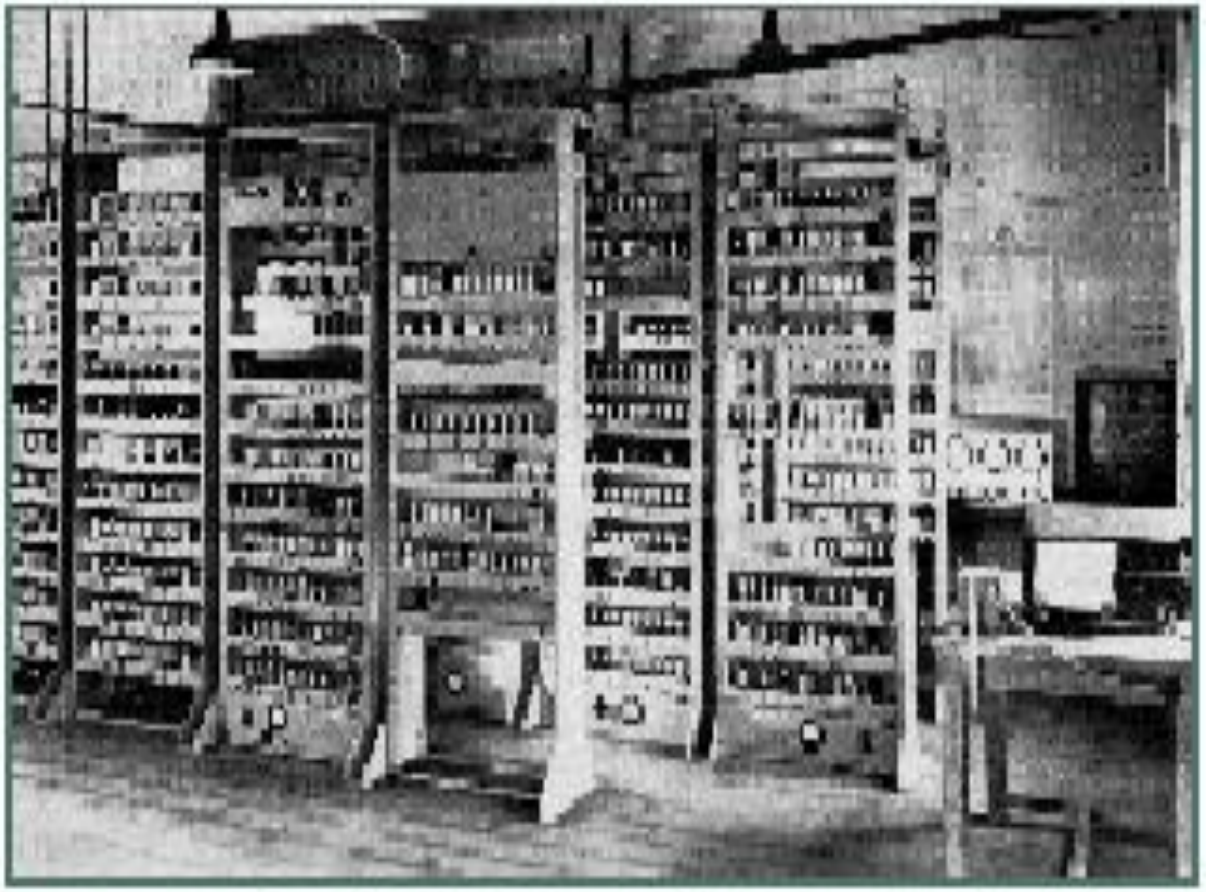
- **The world's first general-purpose electronic computer was ENIAC built by Eckert and Mauchly at the University of Pennsylvania during World War II. However, rewiring this computer to perform a new task requires days of work by a number of operators.**



ENIAC built by Eckert and **Mauchly at the University of Pennsylvania** during World War II

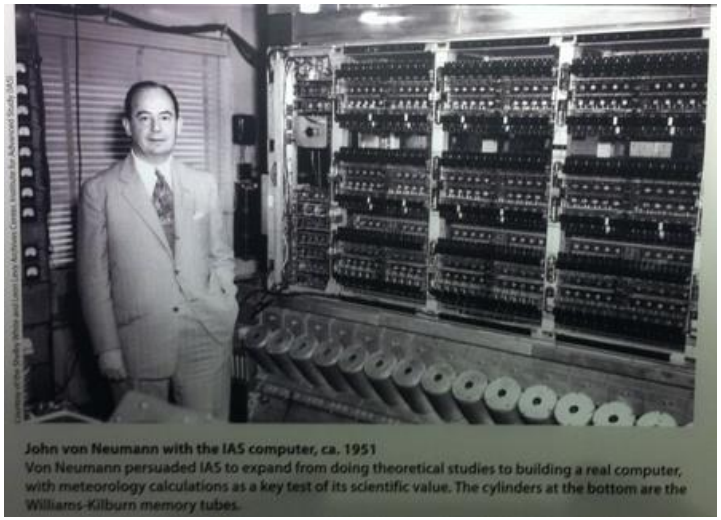
The first practical **stored-program computer**

The first practical **stored-program computer was** EDSAC built in 1949 by Wilkes of Cambridge University.
Now the program in addition to data is stored in the memory so that different problems can be solved without hardware rewiring anymore.

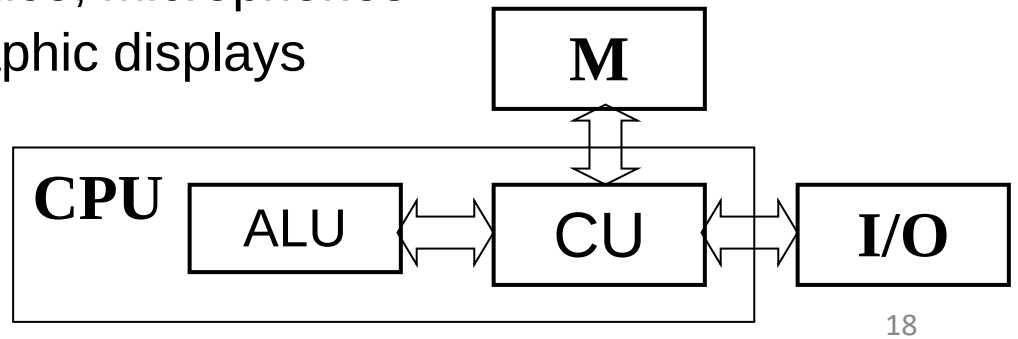


Von Neumann Architecture

- 1945 - "First Draft of a Report on the **EDVAC**"
  - stored-program computer
- 1946 - Summer school at the University of Pennsylvania
- **Computer system** =
  - **CPU** - Central Processing Unit
    - **Arithmetic and Logic Unit**
      (**ALU** + registers = DATA PATH)
    - **CONTROL UNIT** (CU)
  - **Input / Output Unit** (**I/O**)
    - Input Unit = Keyboards, mice, microphones
    - Output Unit = printers, graphic displays
  - **Memory** (**M**)
    - Primary (cache, RAM, HDD)
    - Secondary (CD-ROM, SD)

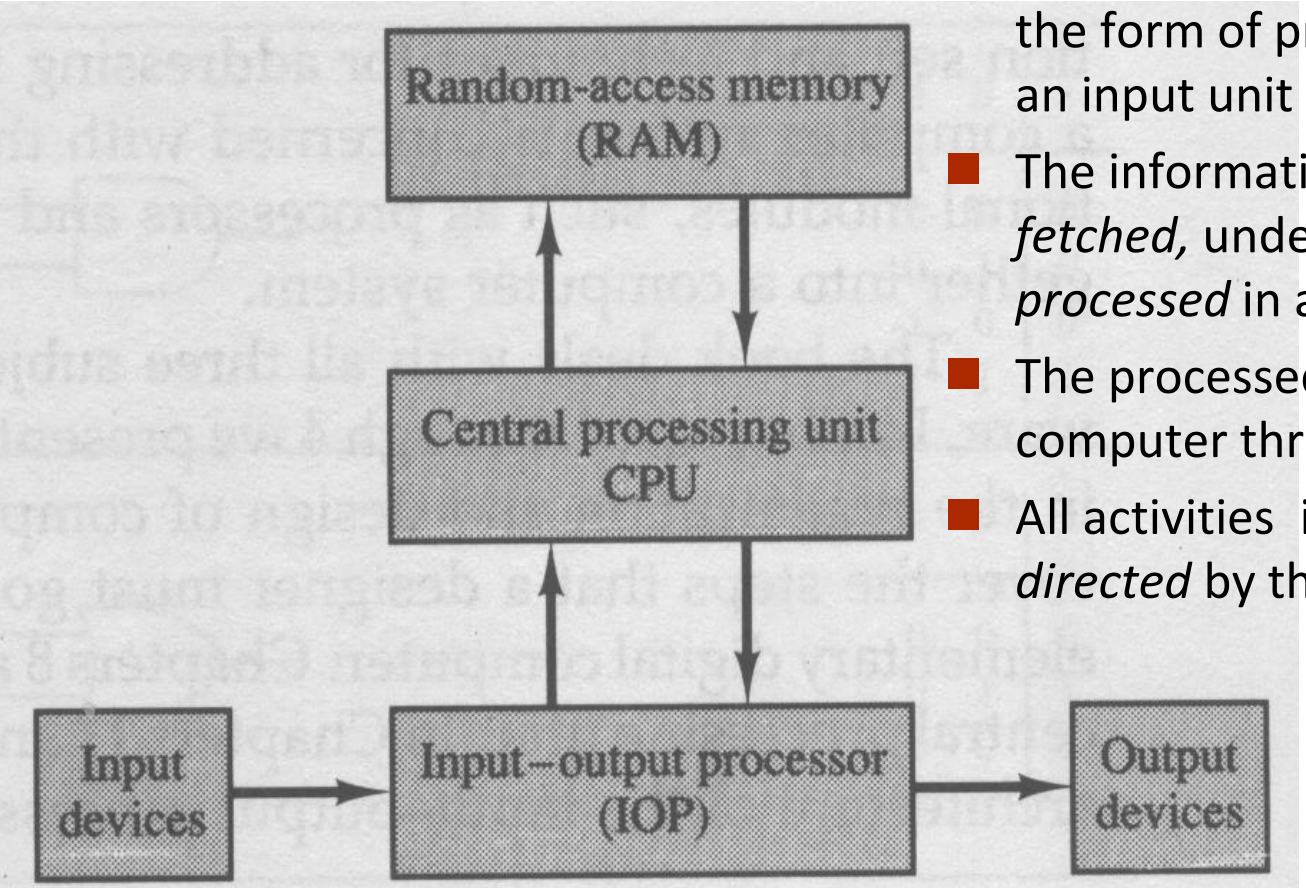


John von Neumann with the IAS computer, ca. 1951
Von Neumann persuaded IAS to expand from doing theoretical studies to building a real computer, with meteorology calculations as a key test of its scientific value. The cylinders at the bottom are the Williams-Kilburn memory tubes.



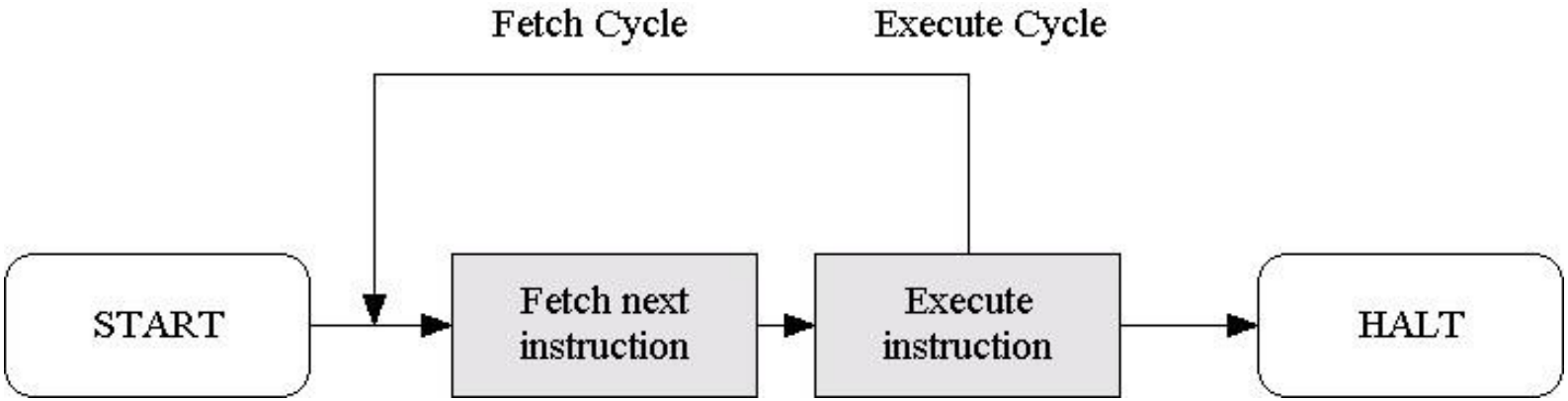
Basic Operation of a Computer

- Computer Architecture (≈ digital computer organization) is concerned with the structure and operation of computers.
- Program: A program is a sequence of computer instructions.

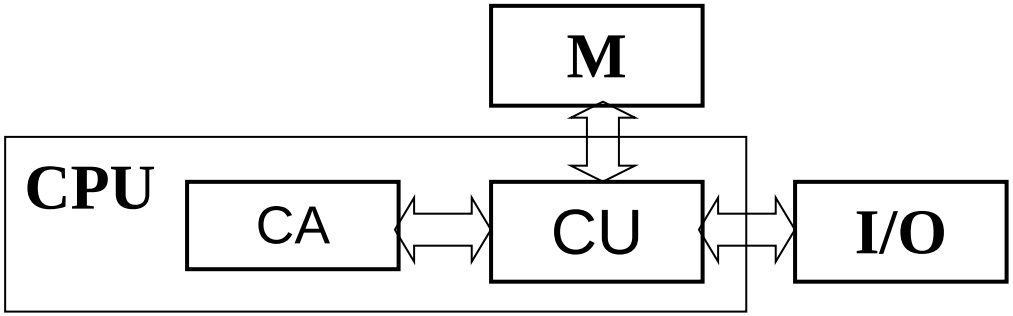


- The computer *accepts* information in the form of programs and data through an input unit and *stores* it in memory
- The information stored in memory is *fetched,* under program control, and *processed* in an ALU
- The processed information *leaves* the computer through an output unit
- All activities inside the computer are *directed* by the control unit

Basic Instruction Cycle



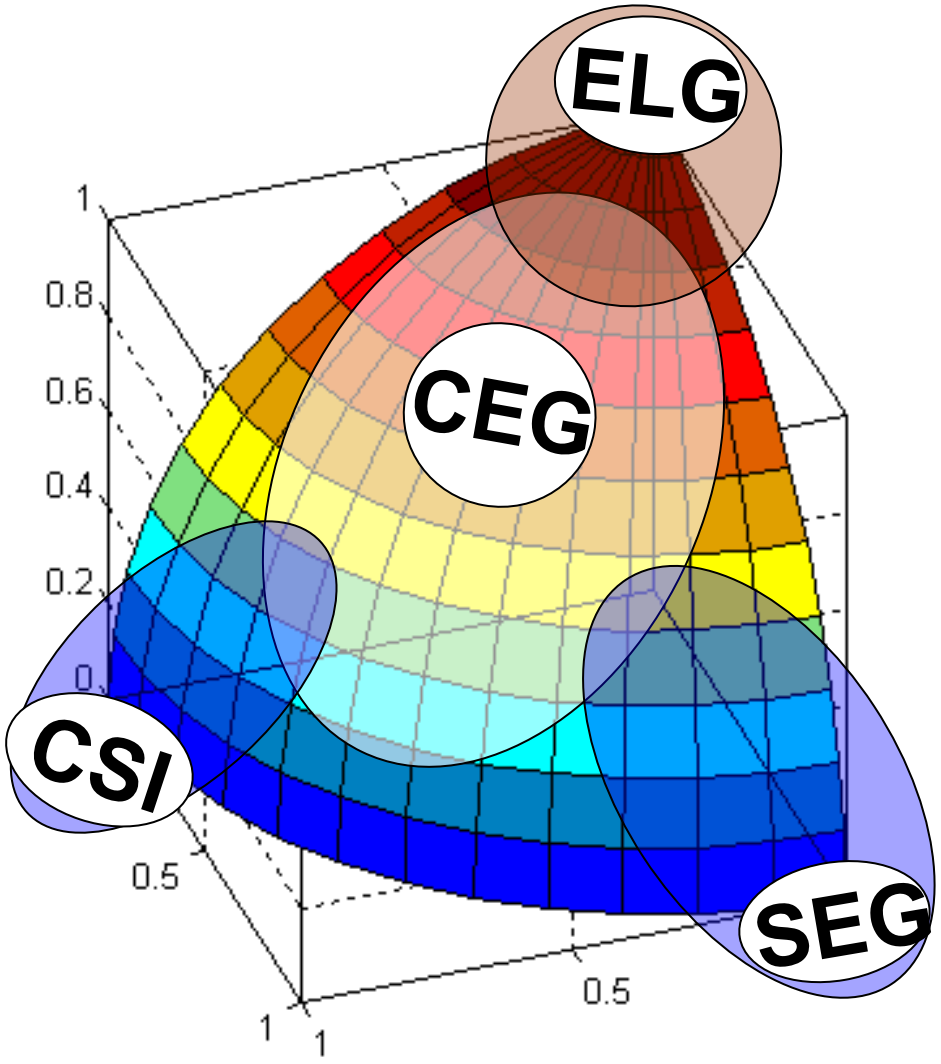
- Computer performs the instruction cycle forever! (or at least until it is turned off, faces an error or is instructed to do so)

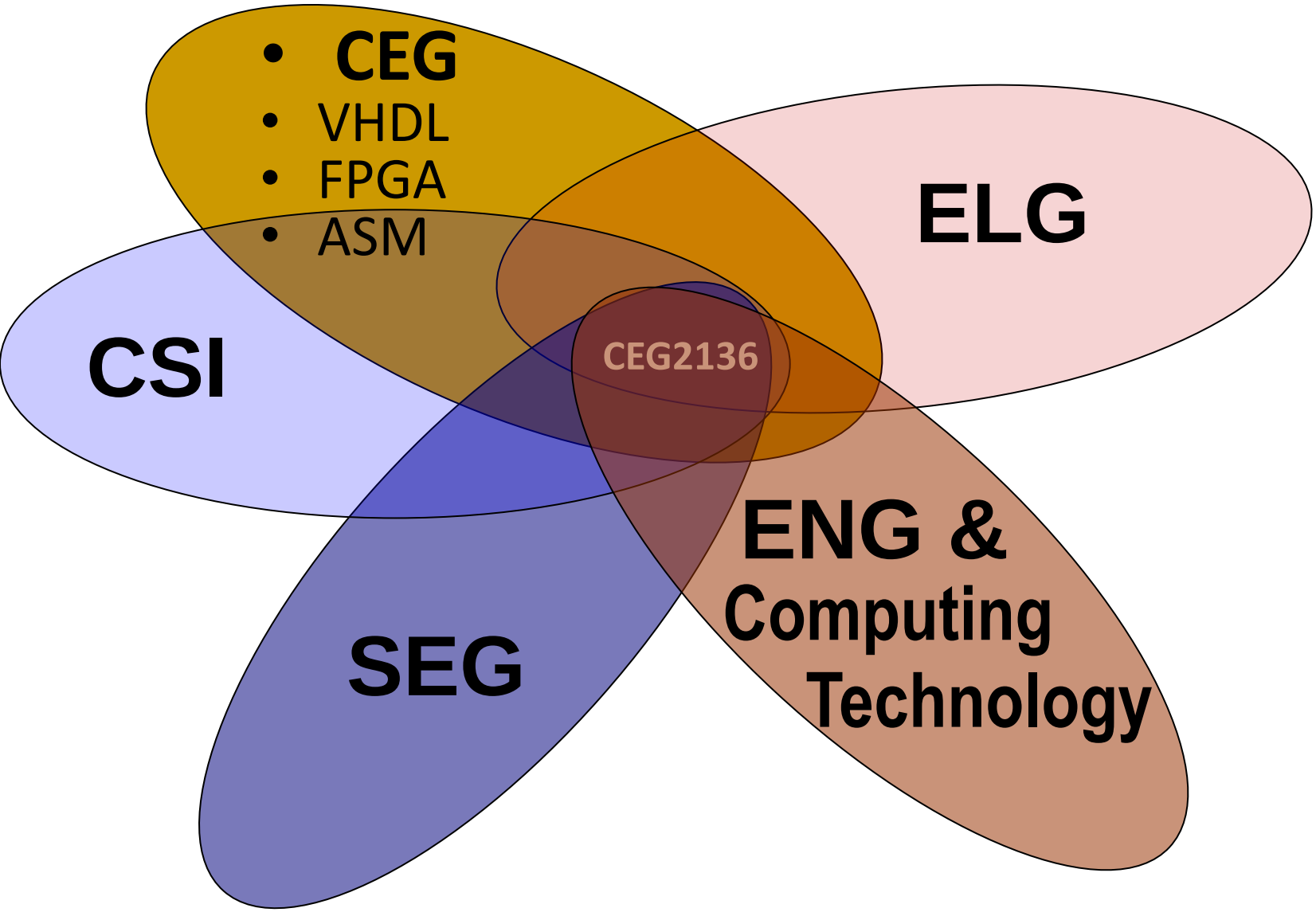


Study programs at EECS

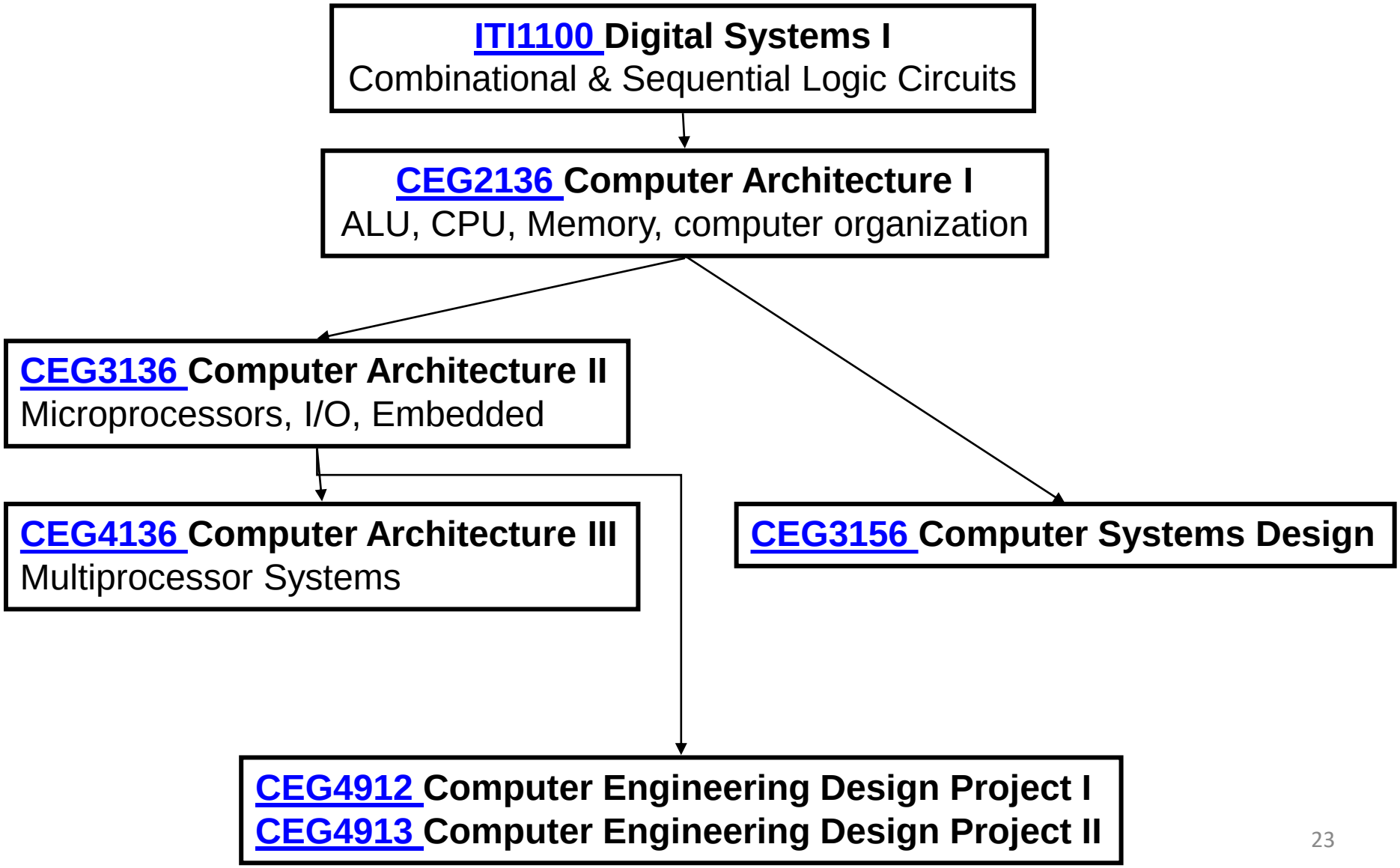
Requires mastery of both:

- ***hardware*** **(overlapping with Electrical Eng.)**
- ***software*** **(overlapping with Computer Science and SW Engineering)**




CEG
VHDL
FPGA
ASM
ELG
CSI
CEG2136
ENG &
Computing
Technology
SEG

HARDWARE


ITI1100 Digital Systems I
Combinational & Sequential Logic Circuits
CEG2136 Computer Architecture I
ALU, CPU, Memory, computer organization
CEG3136 Computer Architecture II
Microprocessors, I/O, Embedded
CEG4136 Computer Architecture III
Multiprocessor Systems
CEG3156 Computer Systems Design
CEG4912 Computer Engineering Design Project I
CEG4913 Computer Engineering Design Project II

Digital Systems (DS)

- Used in Communications, Business Transactions, Medical Systems, Internet, Computers, etc.
- Found in Digital Telephones, Digital Cameras, Digital Television, etc..
- DS Represent and manipulate discrete elements of information.
- Set of **finite number** of elements is a discrete set.
- Otherwise it is a continuous set

Digital Systems (DS)

- Discrete elements of information is represented in a digital computer by physical quantities called *signals* such as voltages, currents, etc.
- Electronic devices implement signals.
- Most Today's digital systems use 2 discrete values 0 and 1 and are called binary digits.
- Binary digit (*bit*)= 0 or 1
- Discrete elements of information is represented by a group of bits called a binary code.
- Interpretation of Binary codes depends on the coding system

DIGITAL SYSTEM
(Discrete Information Processing System)

System
is an organized collection of **components** that interact via **links** among themselves to form a whole

System Structure **(= (components, links))**
defines the composition of the system

System Behavior **(= (inputs, outputs))**
defines the functionality of the system

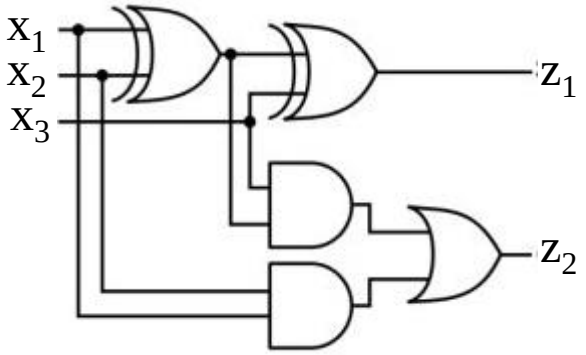
System Design (Synthesis)

is to construct an efficient and cost-effective structure which provides a desired behavior

i.e., Given the behavior (functionality) of a system, construct its structure

$z_1 = \mathbf{f}(x_1, x_2, x_3) = (x_1 \oplus x_2) \oplus x_3$

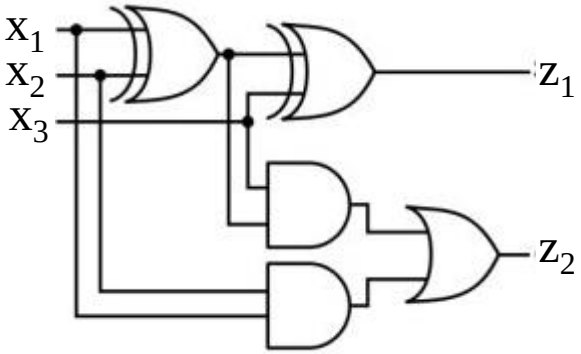
$z_2 = \mathbf{f}(x_1, x_2, x_3) = (x_1 \oplus x_2) \bullet x_3 + x_1 \bullet x_2$



System Analysis

is to determine the behavior exhibited by a structure

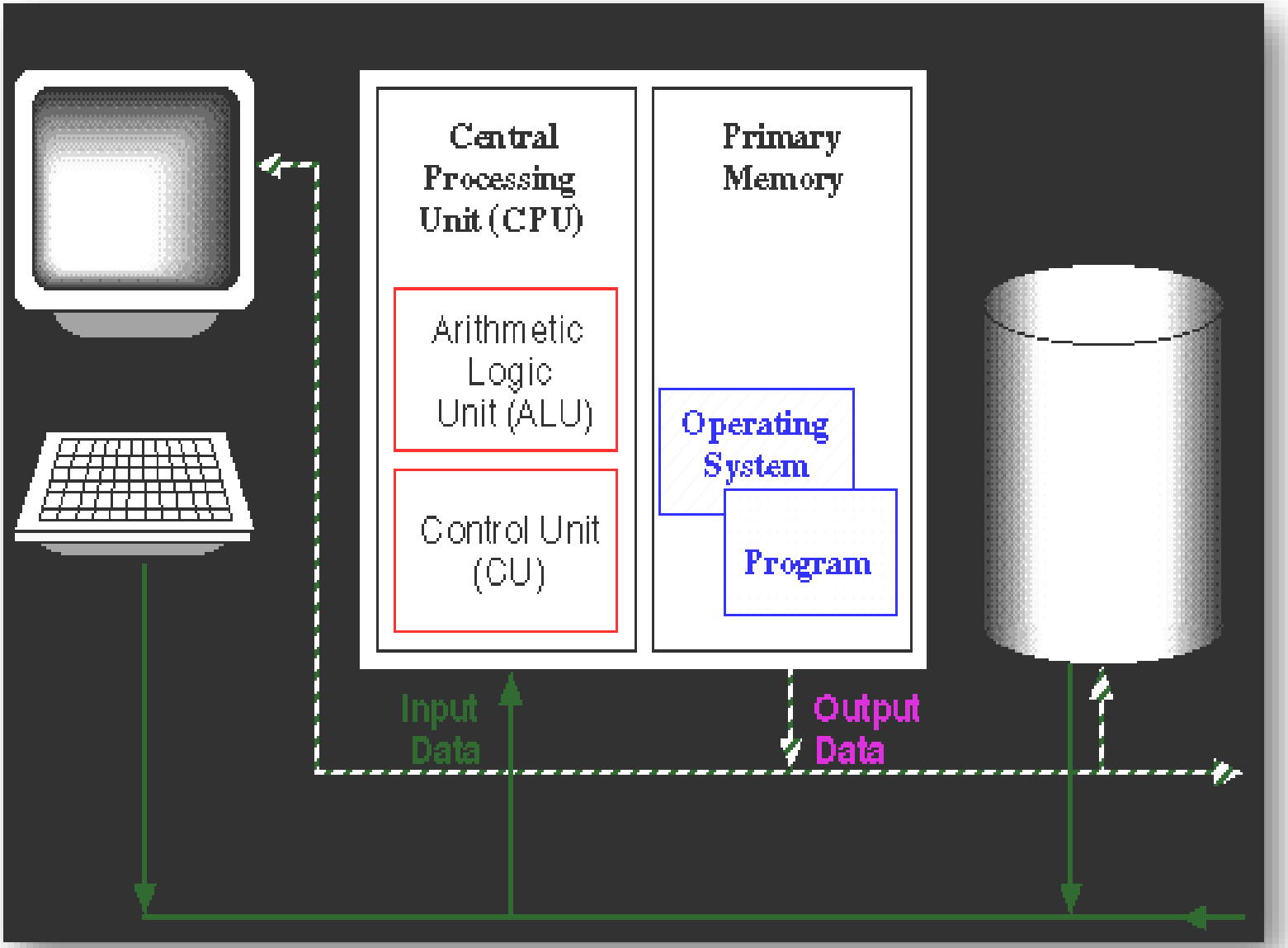
i.e., Given the structure of a system, determine its behavior (functionality)



$z_1 = \mathbf{f}(x_1, x_2, x_3) = (x_1 \oplus x_2) \oplus x_3$

$z_2 = \mathbf{f}(x_1, x_2, x_3) = (x_1 \oplus x_2) \bullet x_3 + x_1 \bullet x_2$

e.g. : Digital Computer is a Digital System




Thank You!
Ευχαριστώ
ขอบคุณ
Vielen Dank
Merci
Teşekkürler
DMnvwd
شكراً
متشكرم
Gracias
Grazie
Bedankt
THANK YOU
Dankie
Köszönettel
Obrigado!
Díky
謝謝
شکریا
WAD MAHAD
GADDA GUEY
SAN TAHAY
감사합니다
Urakoze