

CS-230: Digital Logic Design & Computer Architecture

Course Introduction

Virendra Singh

Professor

Computer Architecture and Dependable Systems Lab

Dept. of Computer Science & Engineering, and

Department of Electrical Engineering

Indian Institute of Technology Bombay

<http://www.ee.iitb.ac.in/~viren/>

E-mail: viren@cse.iitb.ac.in



Lecture 0 (03 January 2022)

CADSL

Happy New Year 2022



WHAT IS THE DIFFERENCE BETWEEN THE COMPUTING INDUSTRY AND THE PAPER TOWEL INDUSTRY?



Industry of Replacement



1971

2022



Industry of new possibilities



03 Jan 2022

CS-230@IITB

4

CADSL

CAN WE CONTINUE BEING AN INDUSTRY OF NEW POSSIBILITIES ???

Personalized
healthcare

Virtual
reality

Real-time
translators



History of Electronics

- There were many inventions in the 20th century:
Airplane, Nuclear Power generation, Computer,
Space aircraft, etc.
- However, everything has to be controlled by
electronics
- **Electronics**

Most important invention in the 20th century

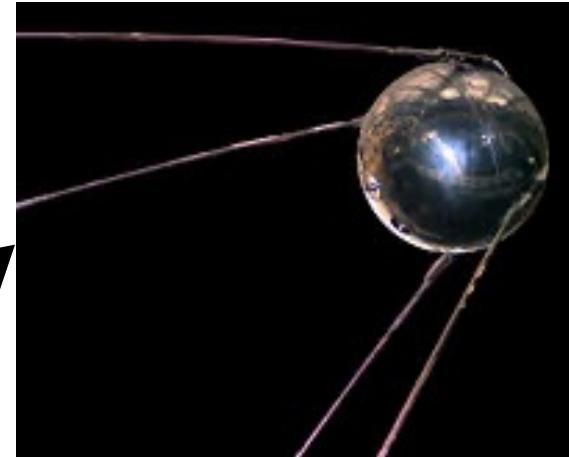


CADSL

World of 1958:

60 Years is a long time!

Artificial Satellite
Sputnik, Oct.4, 1957



Radio → TV (made of Vacuum Tube)



Sony Transistor
Radio Started 1955

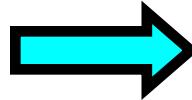
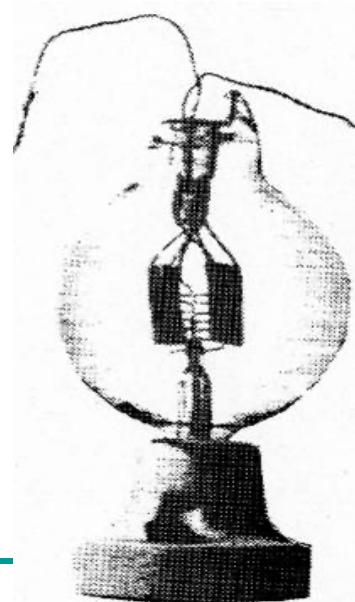
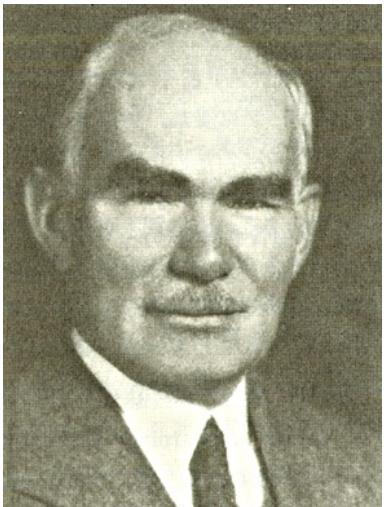


History of Electronics

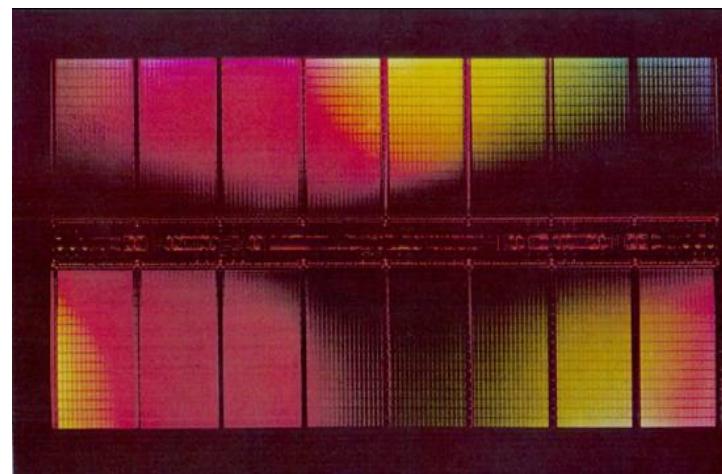
- Electronics is the most important invention of the 20th century
- Electronic Circuits in 100 years

Vacuum tube → VLSI (Very Large Scale Integrated circuits)

15 years ago, it was the 100 year anniversary

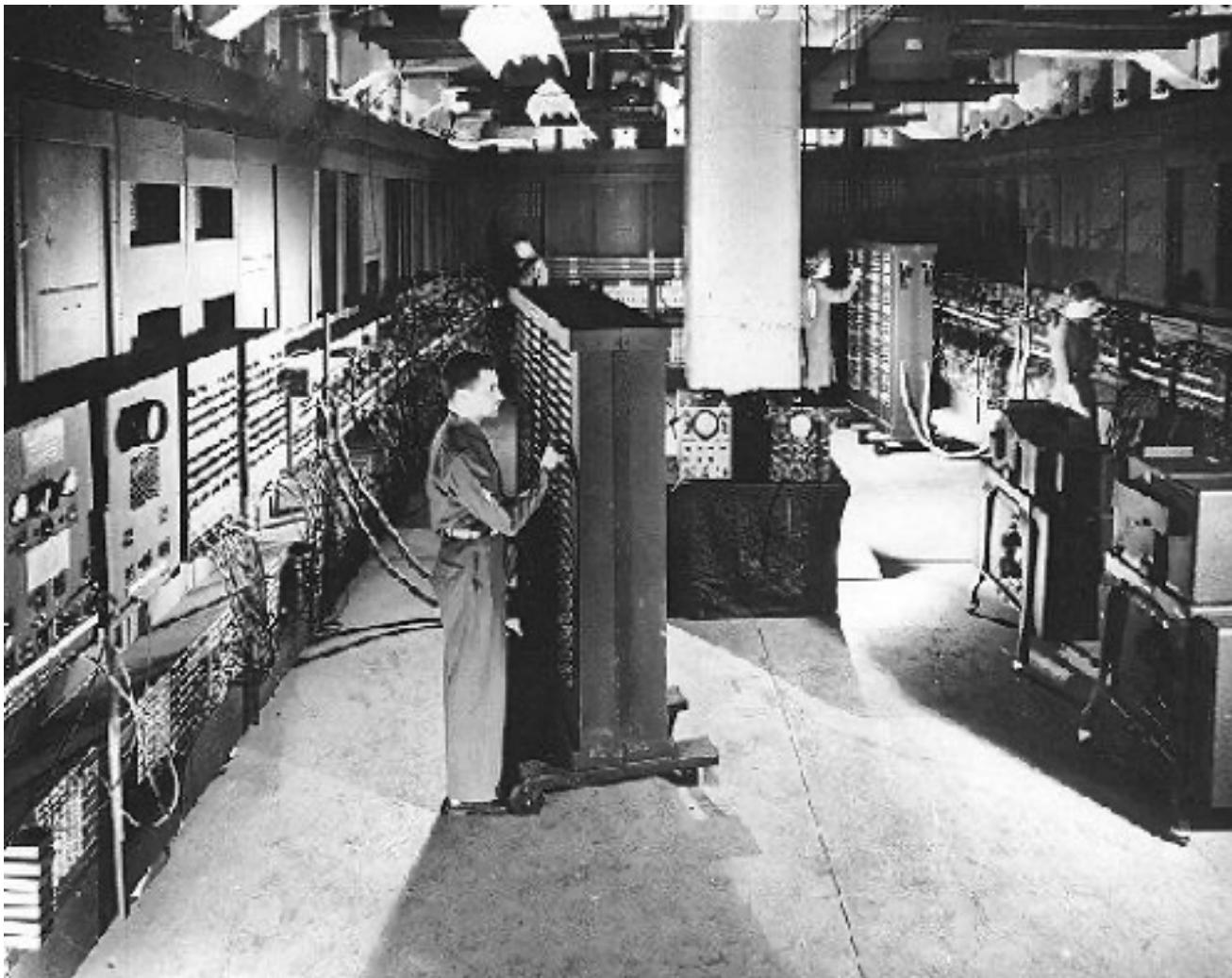


1906

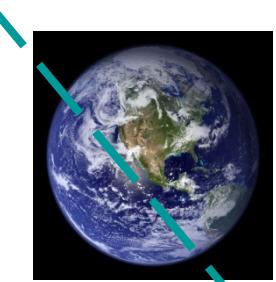


Electronic Computer

First Computer ENIAC: made of huge number of vacuum tubes, Big size, huge power, short life time filament



Wanted: **CUSTOMERS**, who breathe, eat, and live in.....



Global & Regional Political & Macro-Economic Environments



Customer Demand

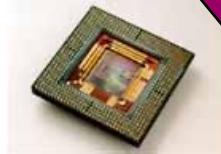
~\$ 50,000B

Electronic End Equipment

~\$ 1050B

Semiconductors

~\$ 400B



Semiconductor
Equipment &
Materials

~\$ 100B



International Techno

03 Jan 2022



Sources: NASA Gov., SEMI

CS-230@MITB

10

CADSL

Interesting Applications



Why Study Digital Design?

- **It's exciting!**; It has never been more exciting!
- It impacts every other aspect of electrical engineering and computer science



Bionics:

Sensors in latex fingers instantly register hot and cold, and an electronic interface in his artificial limb stimulates the nerve endings in his upper arm, which then pass the information to his brain. The \$3,000 system allows his hand to feel pressure and weight, so for the first time since losing his arms in a 1986 accident, he can pick up a can of soda without crushing it or having it slip through his fingers. *One Digital Day*

Next Generation Vehicles



Next Generation Vehicles

WILL IT FIT IN MY GARAGE?

- Price: £36,025 - £49,945
- Length: 16ft 1in
- Width: 6ft 1in
- Fuel consumption: 40.9 mpg
- 0 to 62 mph: 4.8 seconds

■ The new 5-series BMW allows driver to take hands off steering wheel for up to 30 seconds - at speeds of up to 130mph where legal.

P ■ A remote control parking app allows the driver standing outside the vehicle to park the car into or out of a tight parking spot or garage where access is restricted.

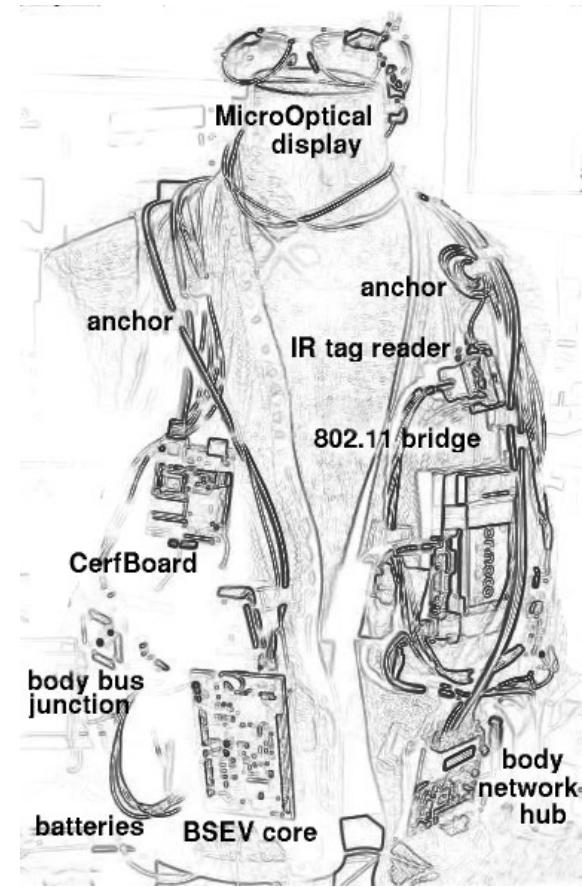
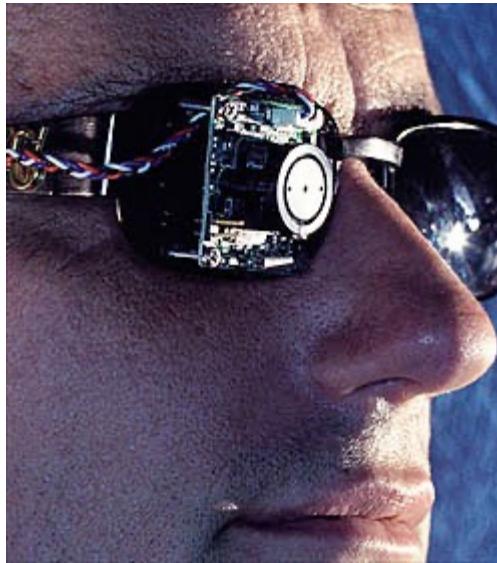
■ Radar sensors check for traffic at junctions

■ Overtakes cars on motorways and dual carriageways by itself from 44mph to 112mph if driver holds down indicator.

■ Gesture control allows drivers to swipe, point or make circular motions to choose music, or with a 'wave of a hand' get rid of an unwanted phone

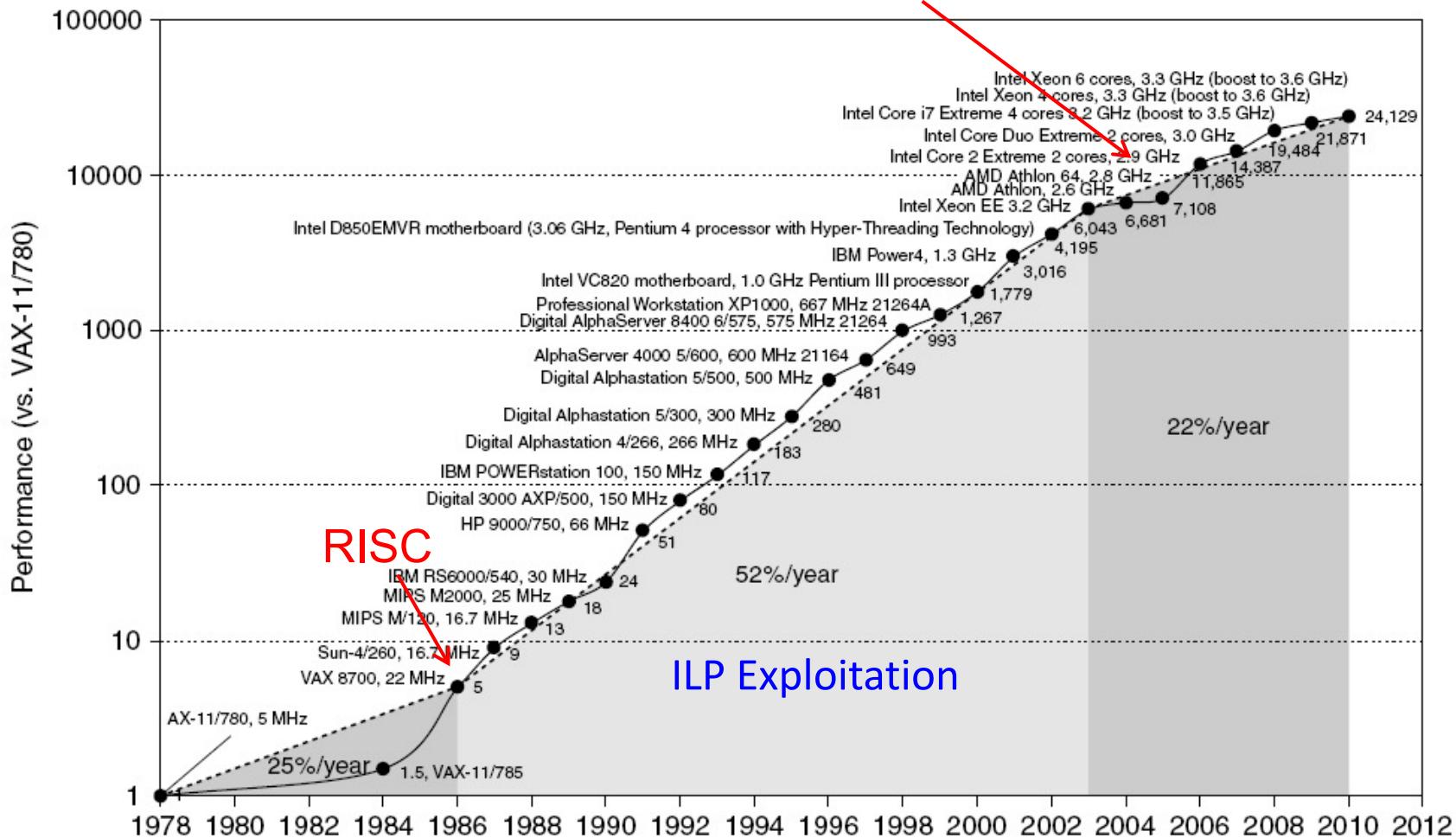
■ The car will send a live visual alert to your mobile phone if it detects someone trying to break into it or if it has been hit by another vehicle. Four cameras will record the face of the villain trying to steal it or the car that hit it.

Why to Study Digital Design?



Single Processor Performance

Move to multi-processor



Putting it all in Perspective...

“If the automobile had followed the same development cycle as the computer, a **Rolls-Royce would today cost \$100**, get a million miles per gallon, and **explode once a year, killing everyone inside.**”

– *Robert X. Cringely*

Technical Writer, Broadcaster

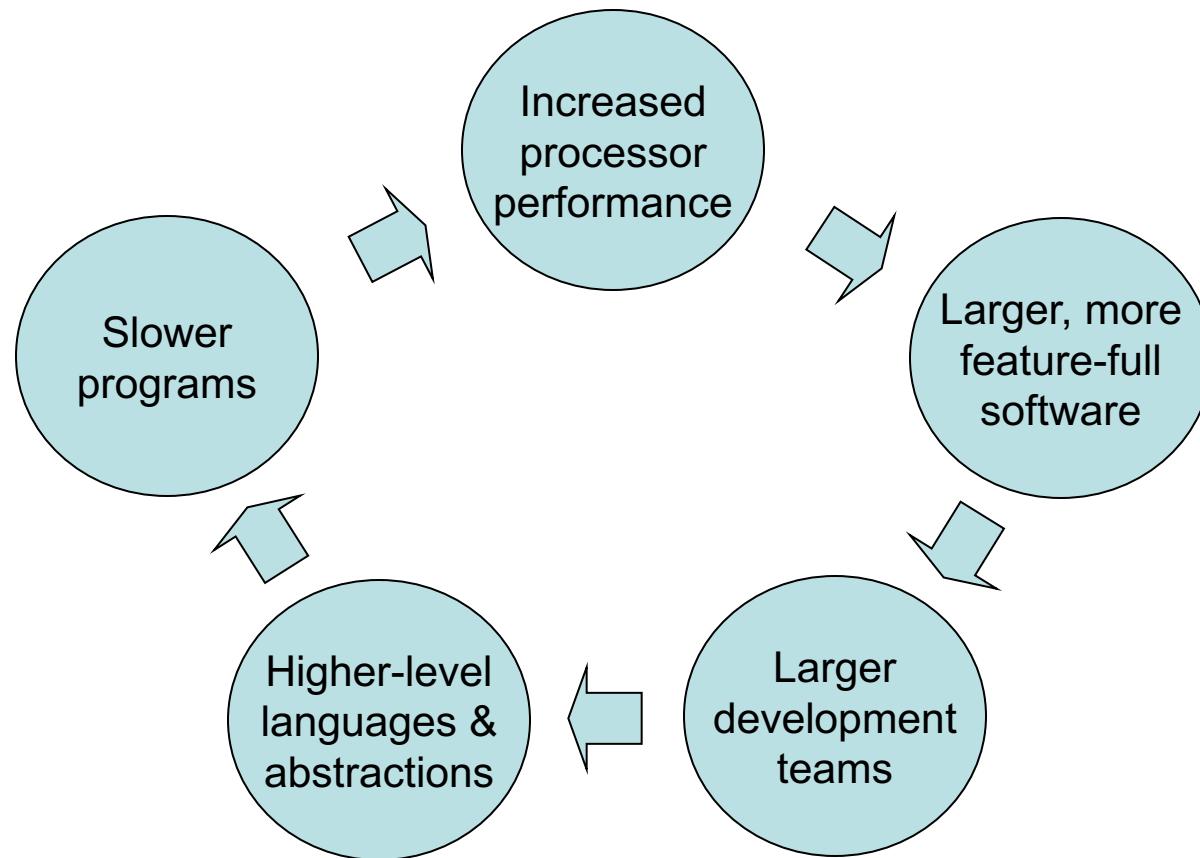
<http://www.pbs.org/cringely/about/>

Triumph of the Nerds

A history of the PC industry,
An ABC program a few years ago



Virtuous Cycle, (1950 – 2005)



World-Wide Software Market (per IDC):
\$212b (2005)



LOGIC



What is logic?

- Logic is the study of valid reasoning.
- That is, logic tries to establish criteria to decide whether some piece of reasoning is valid or invalid.



Valid Reasoning

- While in every piece of reasoning certain statements are *claimed* to follow from others, this may in fact not be the case.
- Example: “If I win the lottery, then I’m happy. However, I did not win the lottery. Therefore, I am not happy.”
- A piece of reasoning is *valid* if the statements that are claimed to follow from previous ones do *indeed* follow from those. Otherwise, the reasoning is said to be *invalid*.



Logic

- Crucial for mathematical reasoning
- Used for designing electronic circuitry
- Logic is a system based on **propositions**.
- A proposition is a statement that is either **true** or **false** (not both).
- We say that the **truth value** of a proposition is either true (T) or false (F).
- Corresponds to **1** and **0** in digital circuits



The Statement/Proposition Game

- “Elephants are bigger than mice.”

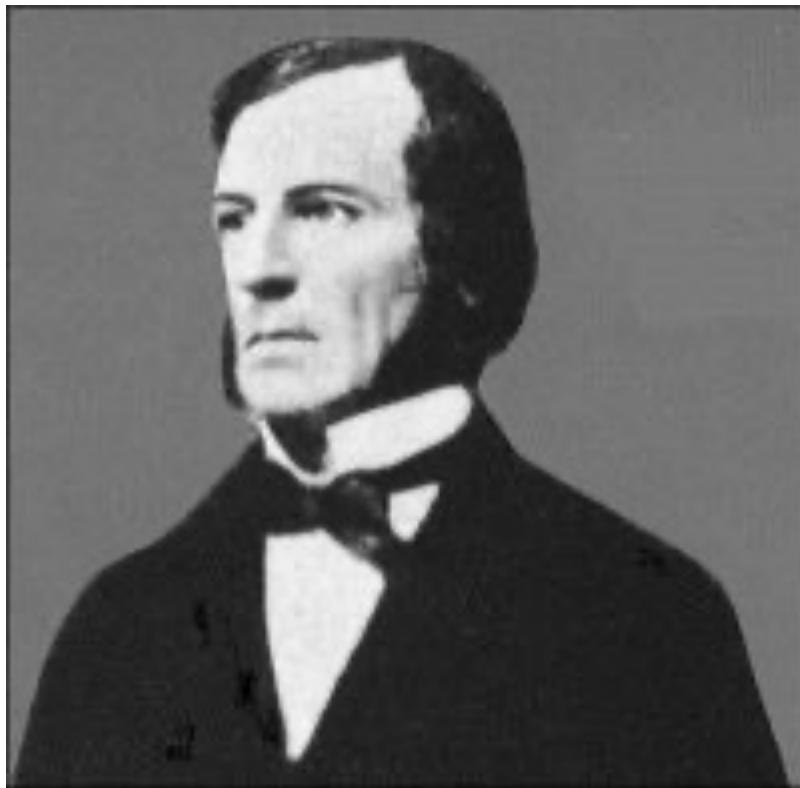
Is this a statement? yes

Is this a proposition? yes

**What is the truth value
of the proposition?** true

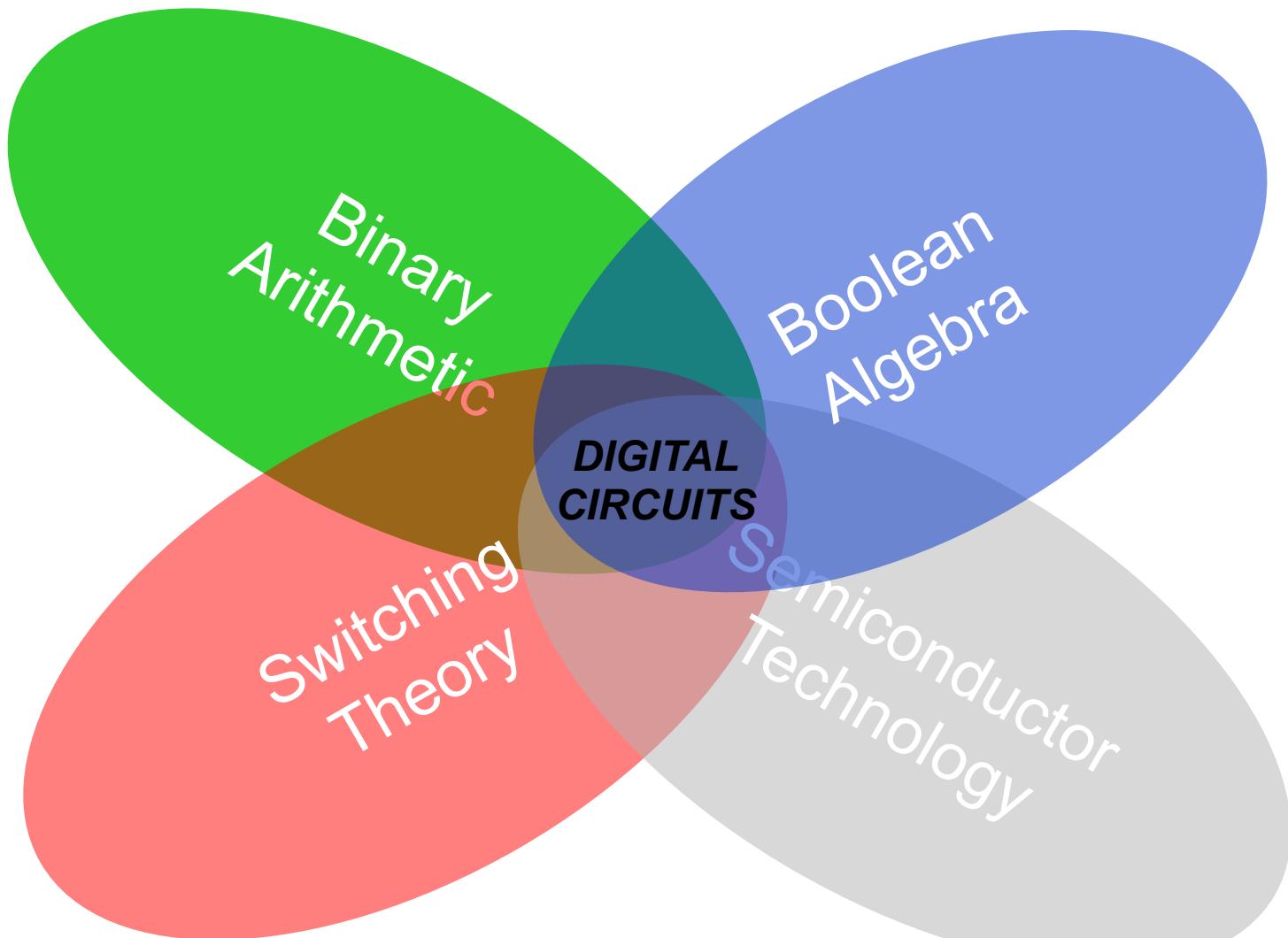


George Boole, 1815-1864



- Born, Lincoln, England
- Professor of Math., Queen's College, Cork, Ireland
- Book, *The Laws of Thought*, 1853

Digital Systems



Course Outline

- ❖ Introduction to Boolean Algebra [1 week]
- ❖ Combinational Circuit Design [2 Weeks]
- ❖ Sequential Circuit Design [2 weeks]
- ❖ Instruction Set Architecture (ISA) [2 Weeks]
- ❖ RISC Processor Design [3 Weeks]
- ❖ Pipelined Design [2 Weeks]
- ❖ Memory System Design [2 Week]
- ❖ GPU Architecture [if time permits]



Course Schedule

Class Hours: Slot 2

- ❖ Monday: 9:30 am to 10:30 am
- ❖ Tuesday: 10:30 am to 11:30 am
- ❖ Thursday: 11:30 am to 12:30 pm

Office Hours: TBD



Course Evaluation

- ❖ Mid Term Exam (20%)
 - Open Book/Notes Exam
- ❖ Final Exam (35%)
 - Open Book/Notes Exam
- ❖ Assignments (20%)
 - Set of assignments will be given periodically
- ❖ Continuous Evaluations (25%) – weekly quiz
 - Weekly Quiz – Open Book (90% best will be counted)
- [Bonus] Surprise Quizzes (5%)
- **[BONUS]** Project (10%)



Grades

Absolute Grade

- > 90: AA
- 81 – 90: AB
- 71 – 80: BB
- 61 – 70: BC
- 51 – 60: CC
- 45 – 50: CD
- 40 – 44: DD
- < 40 : FR



Books

- Switching and Finite Automata Theory
 - Kohavi and Jha
- Digital Design
 - John F Wakerley
- Digital Design
 - Moris Mano
- Computer Organization and Design
 - Patterson and Hennessy



Thank You

