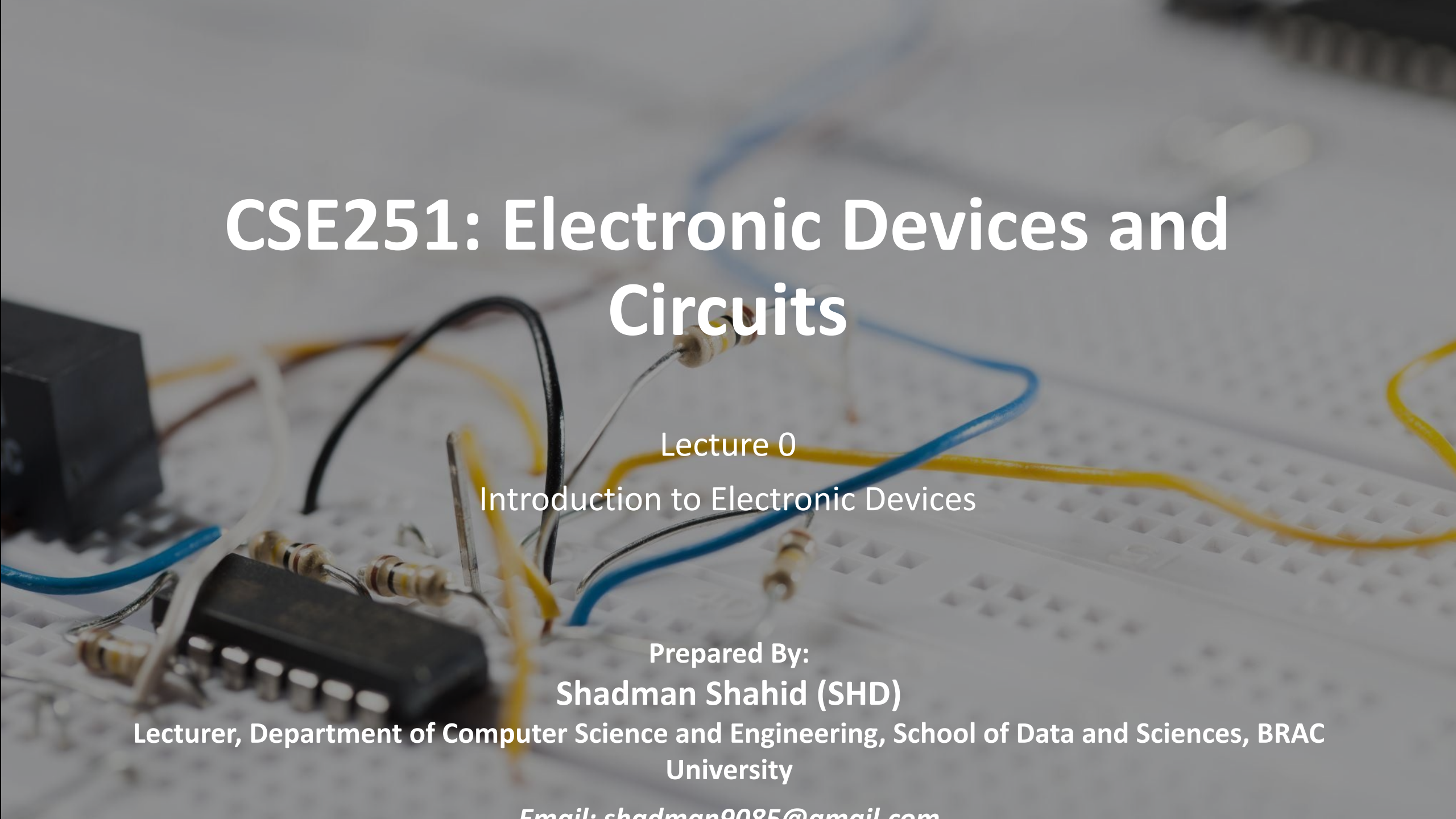

CSE251: Electronic Devices and Circuits

Lecture 0

Introduction to Electronic Devices

Prepared By:

Shadman Shahid (SHD)

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Outline

- Logistical information
  - Instructor Information
  - Administrative Details
  - Marks Distribution
  - How to get an A/A+ in CSE251?
  - How to ~~get an A/A+~~ **pass** in CSE251?
  - Course Outline
  - Course Outcome (**CO**s)
- Introduction
  - Abstraction Levels
  - Historical Perspective
  - Vacuum Tubes
  - Computer Systems with BJTs (60s)
  - Computer Systems with MOSFET (60s)
  - Moore’s Law
  - Some Future Outlook

Instructor information

- Shadman Shahid [HAD]
- Seat No. – 4N159:
  - Consultation: **SUNDAY – 11 AM to 2 PM**
    MONDAY / THURSDAY – 11 AM to 2 PM
- Reachable via mail or discord:
  - Mail: ext.shadman.shahid@bracu.ac.bd
  - Discord: shadman<dot>shahid
- Research Interest:
  - Photonics in computational devices

Administrative Details

- Course Discord: Will be updated soon.
- Course Drive folder: CSE251-Spring24-HAD
  - Course Handout – Syllabus, Grading Policy.
  - Course Calendar
  - Homework Assignments
  - Past Exams and Practice Problems
  - Class Notes
  - Recorded Lectures

Marks Distribution

Assessment	Percentage	Total number of assessments	Number of assessment to be graded
Attendance	8%	-	-
Assignment	12%	5	Best N-1
Quiz			Best N-1
Midterm	20%	1	1
Final	20%	1	1
Lab	25%	-	-

*I will take pop quizzes every now and then at the **end** ~~or **beginning**~~ of a class to be added as **2%** bonus mark or as a "**separate assignment**".

Percentage of Classes Attended	Marks
above 70	8
65-69	7.5
60-64	7
55-59	6.5
50-54	6
45-49	5
40-44	4
below 40	0

PS: Bonus will **only be added** to Assignment and Quiz marks. If you obtain the designated **27%** in quiz and assignments, the bonus will not be added to other areas.

Quiz Schedule

Exam	Time	Date	Syllabus*
Quiz 1	3rd Week	5 February	Lecture 1-4
Quiz 2	5th Week	19 February	Lecture 5-8
Quiz 3	7th Week	4 March	Lecture 9-10
Midterm	***8th Week***	**8 March**	***Lecture 1-11***
Quiz 4	10th Week	27 March	Lecture 13-16
Quiz 5	14th Week	22 April	Lecture 17- 19
Final	***15th Week***	***May 02, 2024***	***Lecture 13-22***

How to get an A/A+ in CSE251?

Time Management: Allocate 10 hrs/wk of *regularly scheduled times* in the week outside of class for CSE251:

- 30 min for **reading** of textbook / slides **before** each class
- 30 min for **studying** online notes **before** each class
- 30 min for **studying** these notes **between** classes
- 75 min for **practicing** problems (Check the practice sheet and previous questions).
- 4-5 hrs/wk for HWs / Assignments.

– In a semester, all lectures total only 30 hrs, which is less than 1 week at a job! It's up to you to put in the time to learn

– Get a 1" binder (organize lecture notes/HWs/exams)

– Start assignments early. **Do all problems by yourself first.** If you get stuck, form study groups to work on problems together but **ALWAYS** write-up and submit **YOUR OWN** solutions. Do not blindly copy.

– Ask questions and come to office hrs if you get stuck. Don't let confusion snowball.

How to get an A/A+ in CSE251?

- ***Practice doing problems.*** Get comfortable with the math manipulations and associated physical meaning, and you will find exam problems to be easier
  - HW problems
  - Example problems worked in lecture and online class notes
  - Old exam problems
  - Office hours
- ***Review your prerequisites.***
  - Node analysis, Mesh Analysis, Circuit solving techniques! CSE250
- ***Come to class!!***
  - *HW & Participation are a significant part of your grade*
  - I will discuss topics to be emphasized on exams and give hints about how to approach the more difficult homework problems

How to ~~get an A/A+~~ **pass** in CSE251?

- ***Attendance + Assignments + Quiz + Lab:***

  $8\% + 12\% + 25\% + 15\% = 60\%$

  - Suppose, you attend all the classes. Get 83% in Assignments, 83% in Lab, 75% in Quiz. So, you will get:

  $$8 + 10 + 21 + 11.25 = 50.25\% \text{ !!}$$

  - Try to do well in these continuous assessments and your road to passing CSE251 will be much easier.

- ***Come to class!!***

  – *HW & Participation are a significant part of your grade*

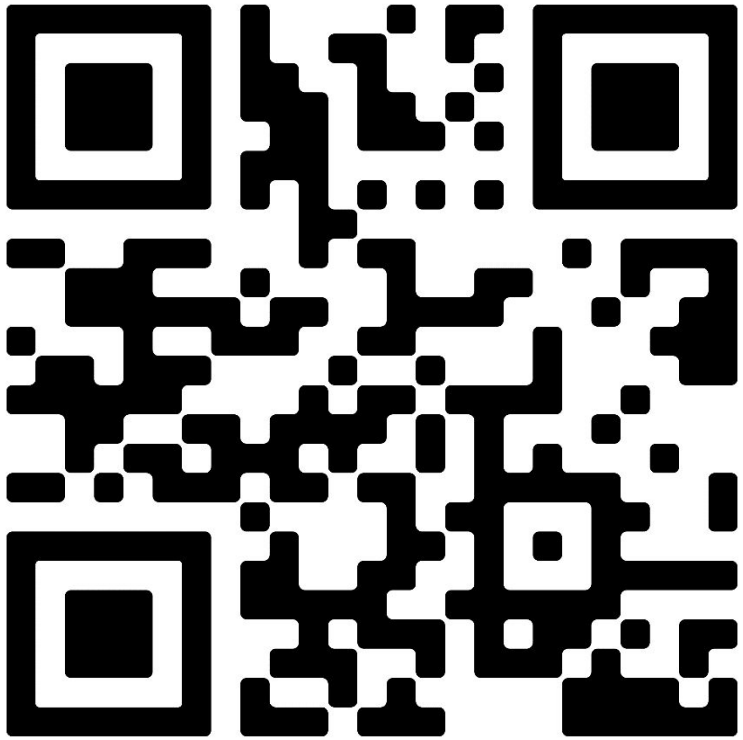
  – I will discuss topics to be emphasized on exams and give hints about how to approach the more difficult homework problems

How to approach CSE251?

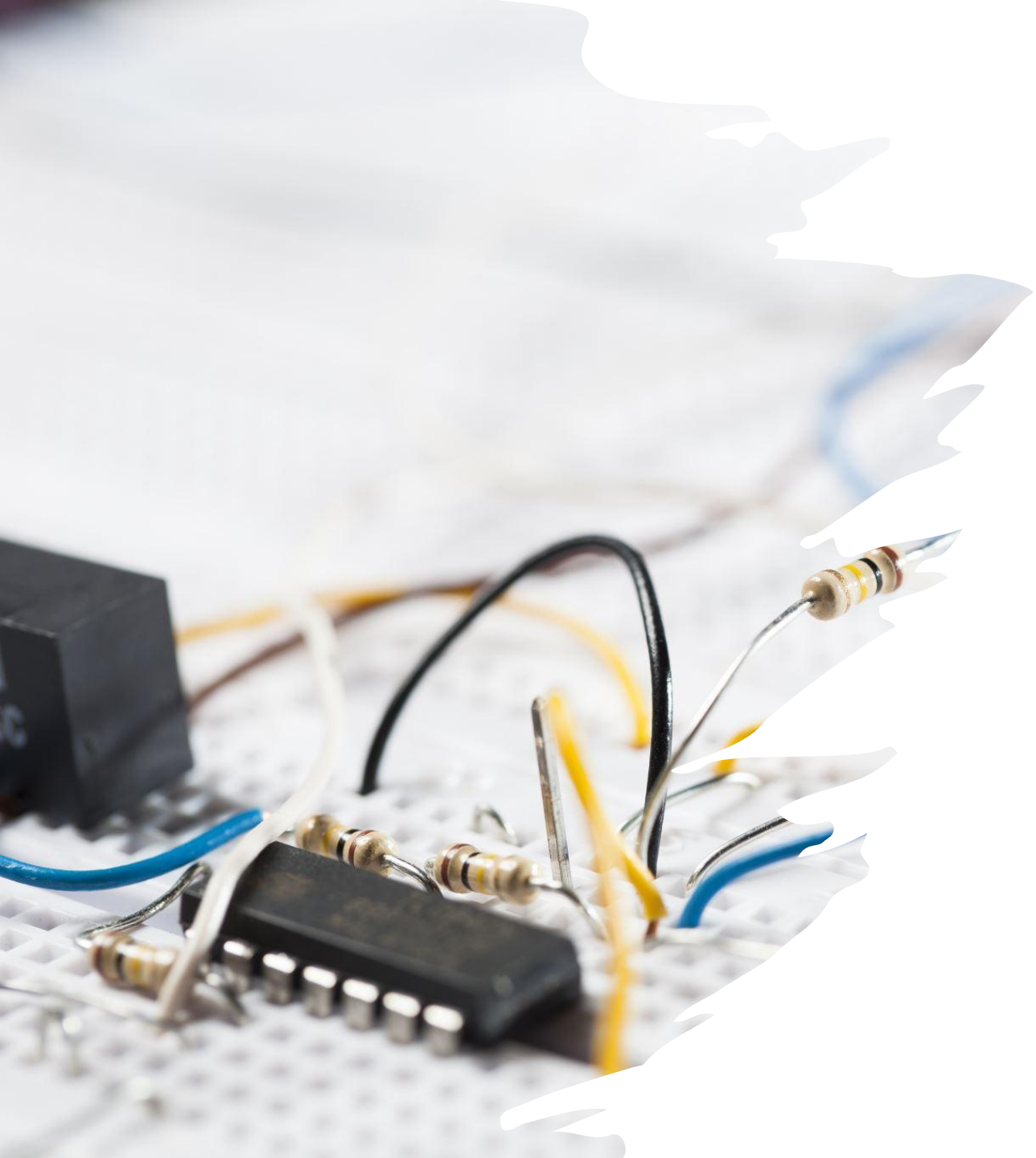
Write down important information. **(See)**

Visualize - Draw - doodle - interact **(Imagine)**

Think and solve. **(Act)**



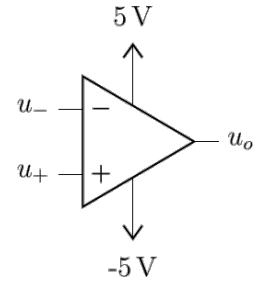
First Day Survey

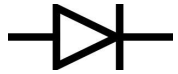


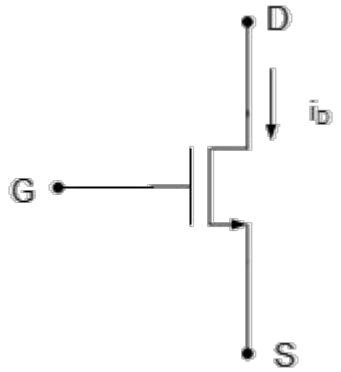
Course outline

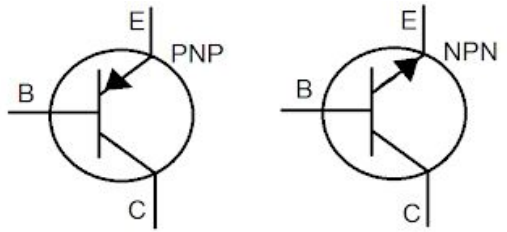
Basically, study **four types** of devices. (Application centric usage)

- OP-AMP
- Diodes
- MOSFET
- BJT



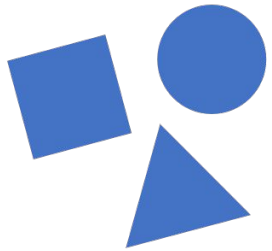






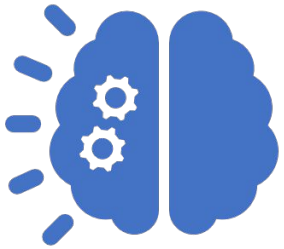
Application: Amplification and **Switching**

Course Outcome



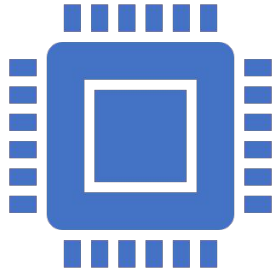
CO1

Understand and compare the **characteristics** and **operation** of electronic devices



CO2

Analyze electronic circuits made from these devices



CO3

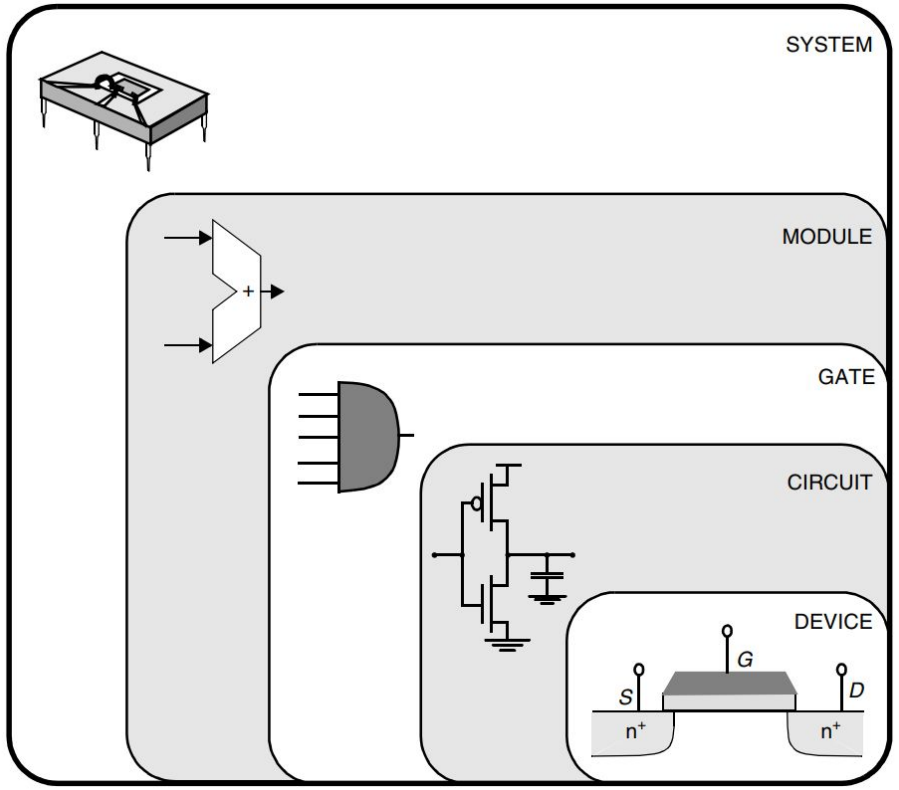
Design various electronic circuits for power-generation and analog signal-processing applications.

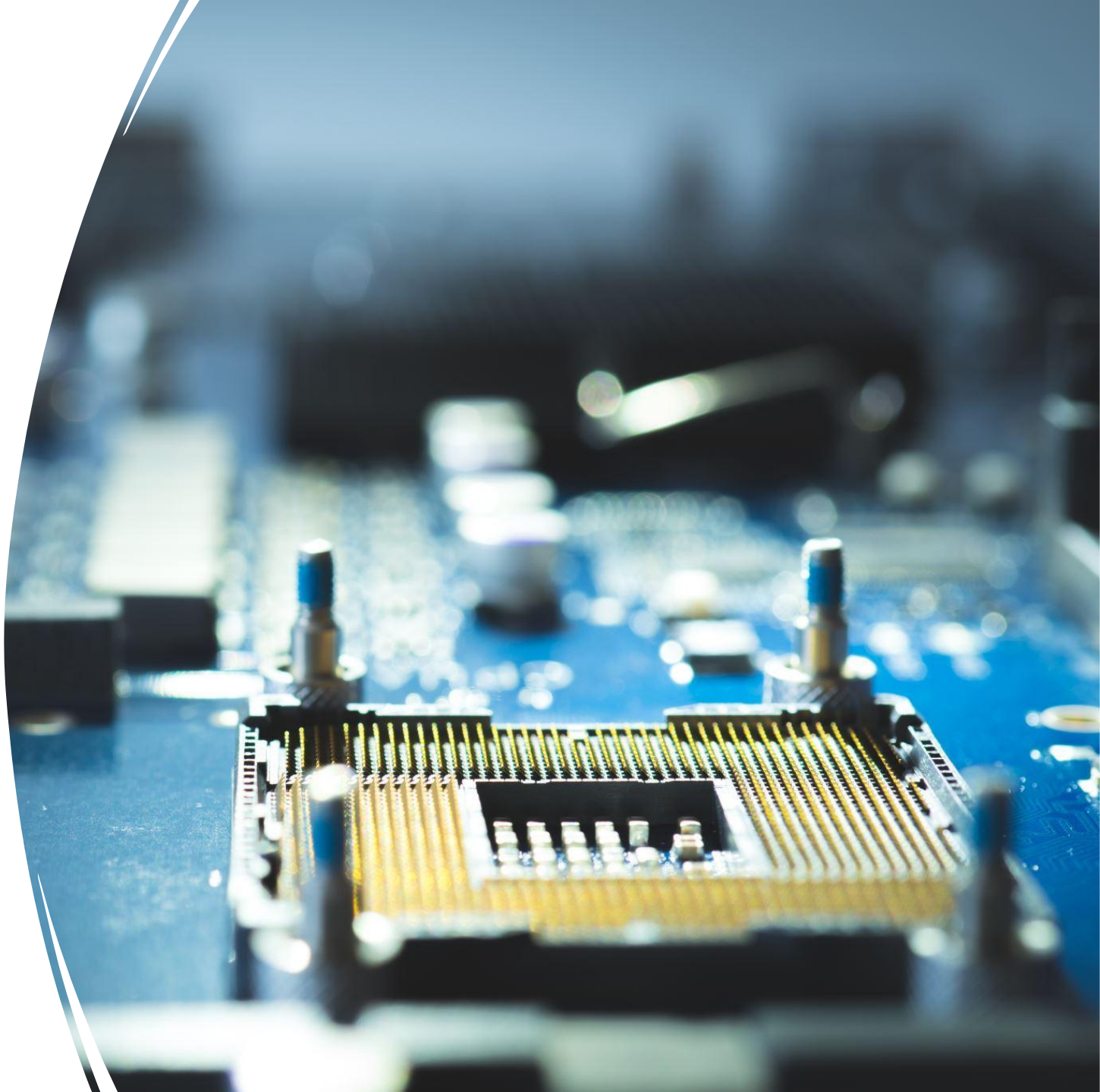
A list of applications (non-exhaustive)

- **Switching**
  - Rectifiers
  - Analog-to-digital (ADC)
  - Digital-to-analog conversion (DAC)
  - Arithmetic operations on analog Signals, e.g, summing, subtracting, exponentiation and generating voltage waveforms of different shapes.

- **Amplification**
  - Regulators
  - Small-signal Amplifiers

Abstraction Levels



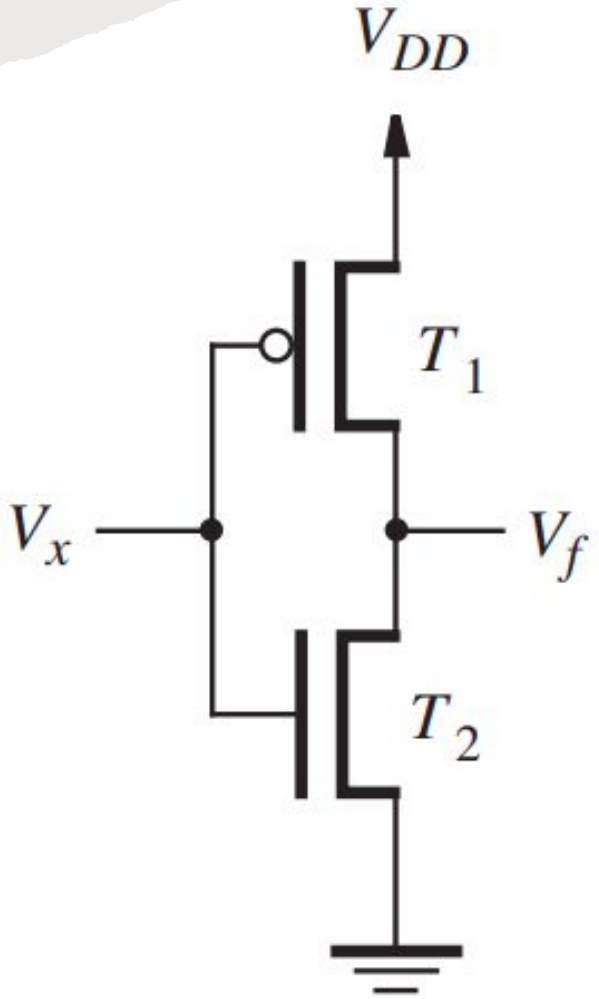


Logic gates –> Electronic Devices

Electronic Devices:

1. Transistors (BJT/MOSFET/ JFET/**FinFET**)
2. Diodes

Amplification and **Switching**



MOSFET realization of a NOT gate.

S. D. Brown and Z. G. Vranesic, *Fundamentals of digital logic with Verilog design*, Third edition. New York: McGraw-Hill Higher Education, 2014.

Historical Perspective

Mechanical gears
(1822 - Difference Engine, Analytical Engine)

- Has it always been like this?
- Eras of Computer evolution:

Electrical switches and
mechanical relays
(1944 - Harvard Mark 1)

1. Gen 1: Mechanical to **Vacuum Tubes** (17th -1940s):

2. Gen 2: **Transistors** (BJT) (1950s): Short-lived

(1951 – 1959)
Switchover to ***transistors*** from ***vacuum Tubes***

3. Gen 3: **Integrated Circuitry** (1960s - Present)

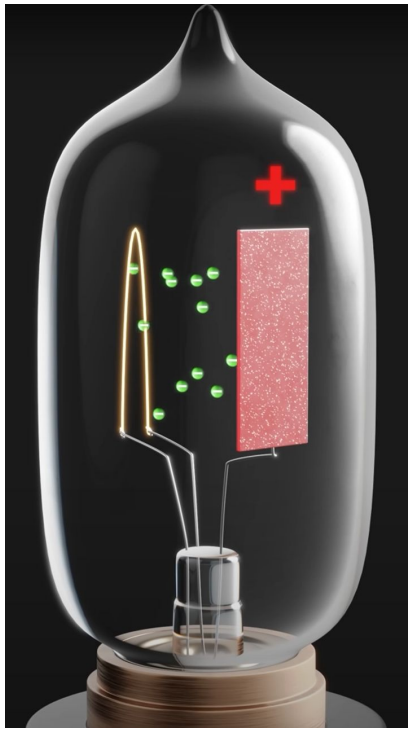
VLSI

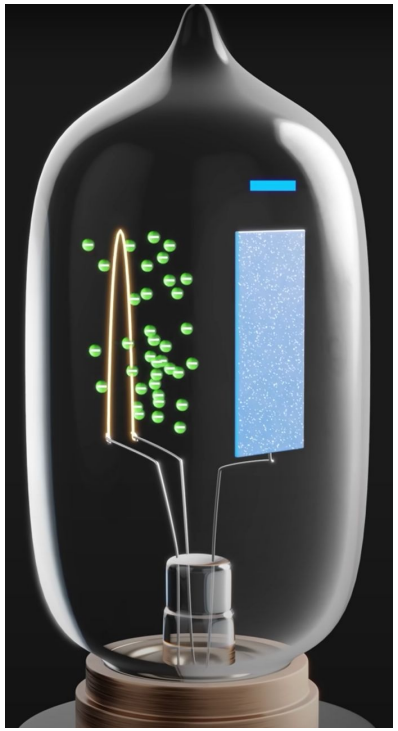
Microcomputers -> Laptops, Smartphones

WWI: 1914 - 1918
WWII: 1939 - 1945

History of Computers (uah.edu)

Vacuum Tubes (1946 - ENIAC)

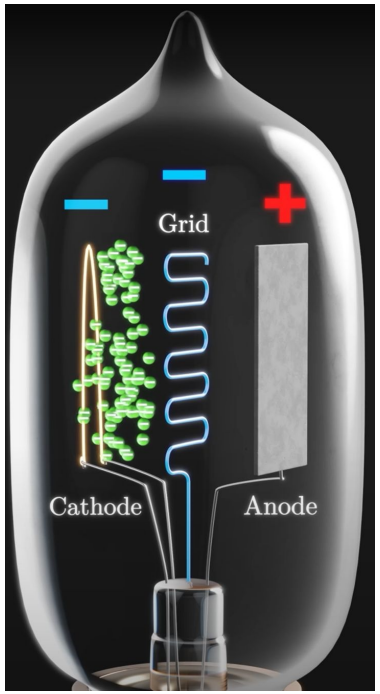


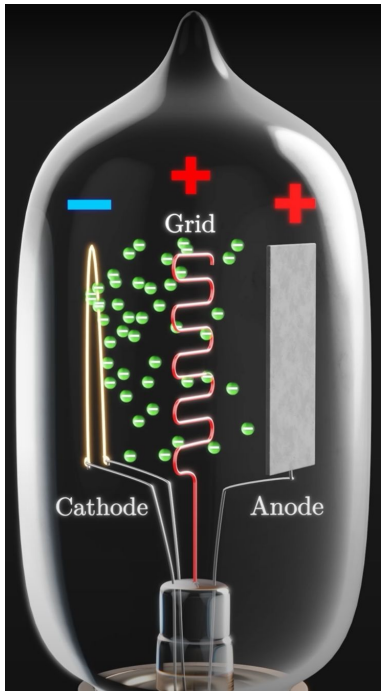


Electron Flow ON Electron Flow OFF

Thermionic Diode

SWITCHING





Small changes in ***Grid*** voltage translate to large voltages at the Anode

Thermionic Triode

AMPLIFICATION

Computer Systems /Processors with BJT (60s)

Computer System	Year
IBM System/360	1964
DEC PDP Series	1960 (PDP-1), 1965 (PDP-8), 1970 (PDP-11)
Control Data Corporation 6600	1964
IBM System/370	1970
Cray-1	1976

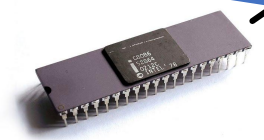
IBM System/360 hybrid BJT circuit

Computer Systems /Processors with MOSFET (70s - Present)

Intel® 4004

1971

10 μm

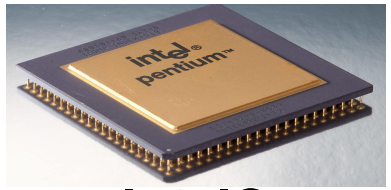


Intel ® 8086 1978

3 μm

65 nm

0.8 μm



Intel® Pentium®

1993

Intel® Core™2 Duo

2006

22 nm

Intel ® Core ™

2010

7 nm

AMD Ryzen 5000

2021

Intel® Core™ 12th gen

10 nm

2021

Processor evolution

(Red: Feature size)

Moore’s Law

The number of transistors in a microchip doubles every two years

What Is Moore's Law

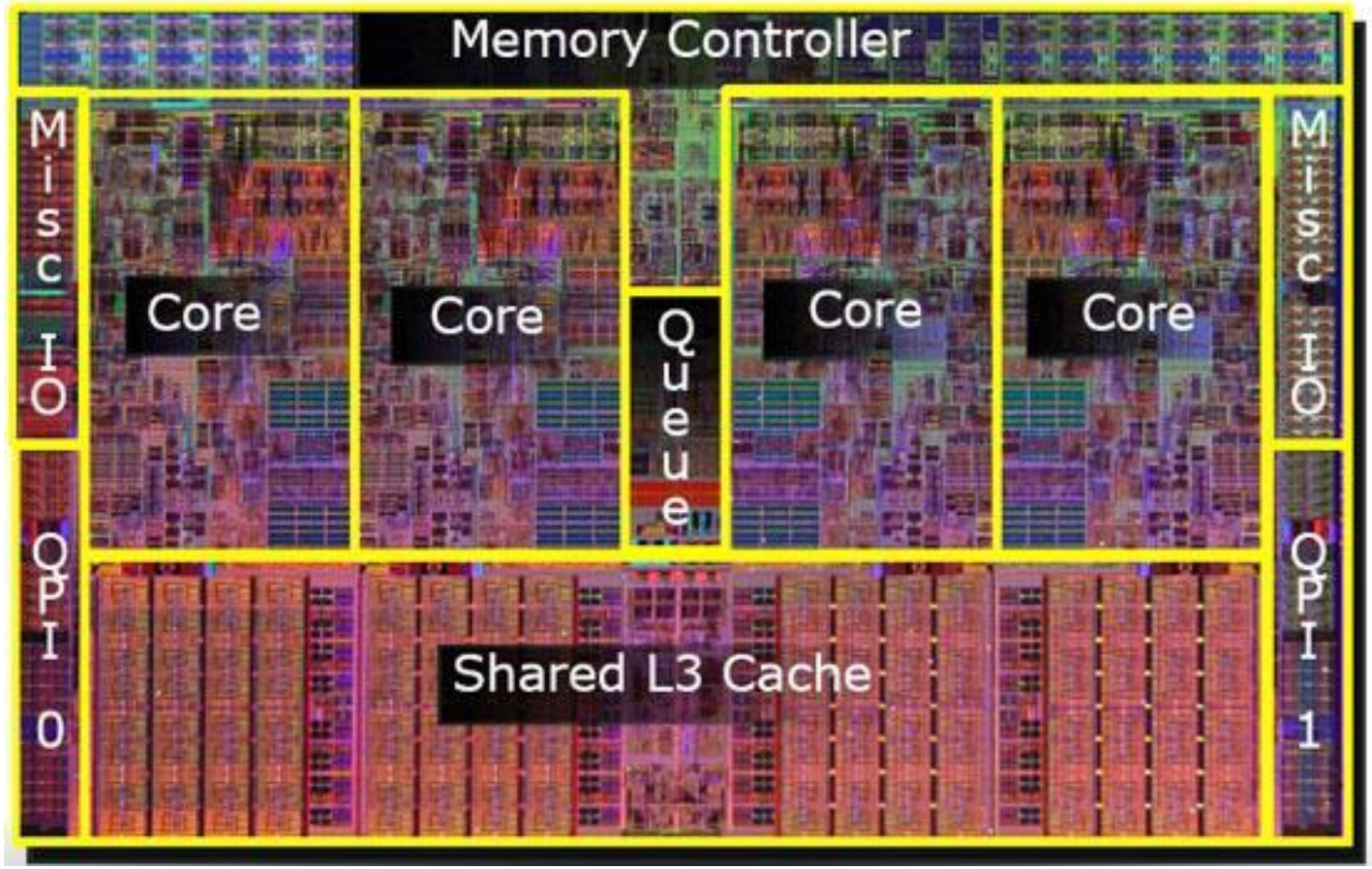
Current scenario and the future

- ~~Ongoing chip shortage!~~
- Two type of companies:
  1. **Fabless** design companies: AMD
     Apple etc.
  2. **Foundries**: Intel
     TSMC
     Samsung
     Global Foundries

Moore's Law is approaching an end.
Possible alternatives for the future:

1. Spintronics
2. Photonics
3. Nano-electronics (Quantum)

An Integrated Circuit Layout of a Processor



List of resources used in this slide

- History of Computers
- More about Vacuum Tubes – Veritasium YouTube
- More information about Semiconductor chip industry
- Moore’s Law

Thank You