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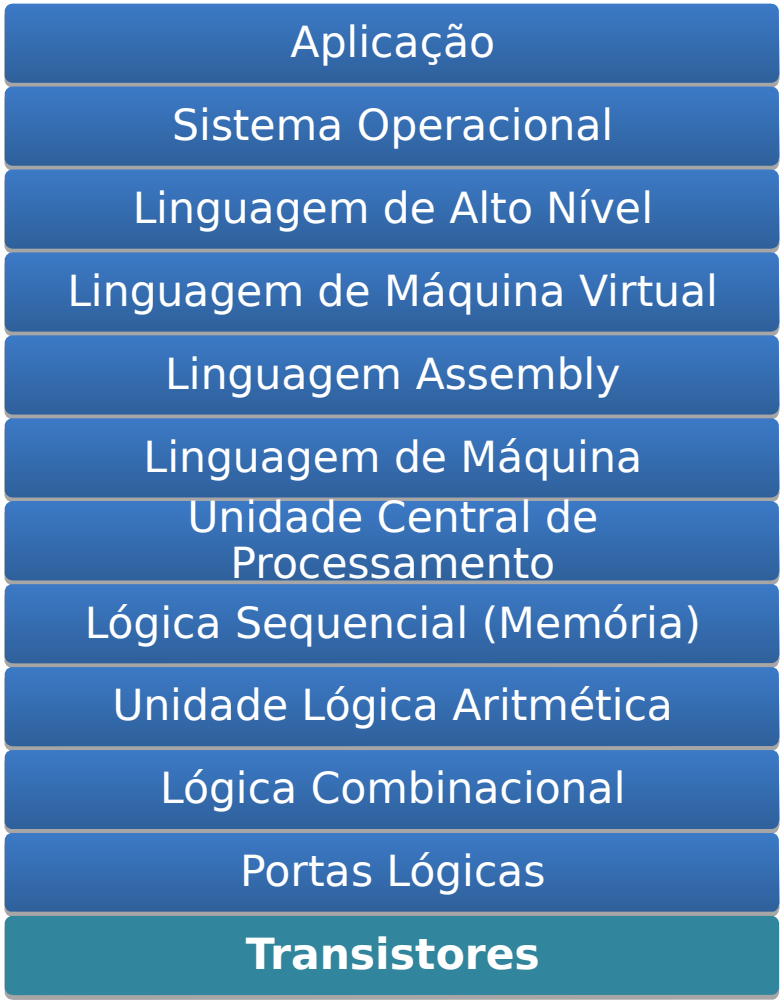
Elementos de Sistemas

Aula 3 – Transistores

"Tais coisas simples, e nós fazemos delas algo tão complexo que nos derrota, quase."
"Such simple things, and we make of them something so complex it defeats us, almost."
***John Ashbery (1927)* poeta americano**
apud Nisan, N. & Schocken, S. 2005. Elements of Computing Systems

Engenharia - Luciano Soares <lpsoares@insper.edu.br>

Níveis de Abstração



Dúvidas ?

RESOLVER QUIZ.

Lembrem-se:

Tragam sua dúvidas anotadas;

Verifiquem sites como:

- Google
- Stack Overflow
- Etc...

Usem o Slack, para perguntar para seus colegas, ninjas e o professor antes da aula

No início era a válvula...

By Stefan Riepl (Quark48) - Self-photographed, CC BY-SA 2.0 de, https://commons.wikimedia.org/w/index.php?curid=14682022

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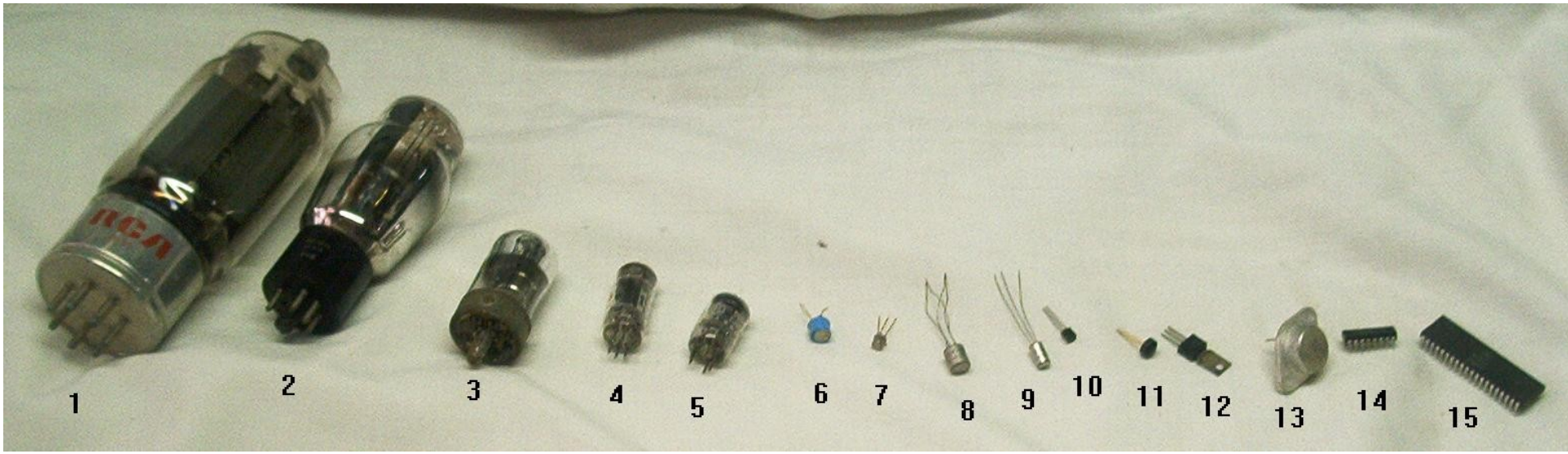
Harwell Dekatron vacuum-tube (valve) computer, 1951-57 - National Museum of Computing, Bletchley Park, England

Evolução !

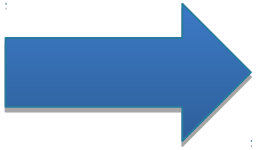
http://mmncny.org/exhibits/296-2/

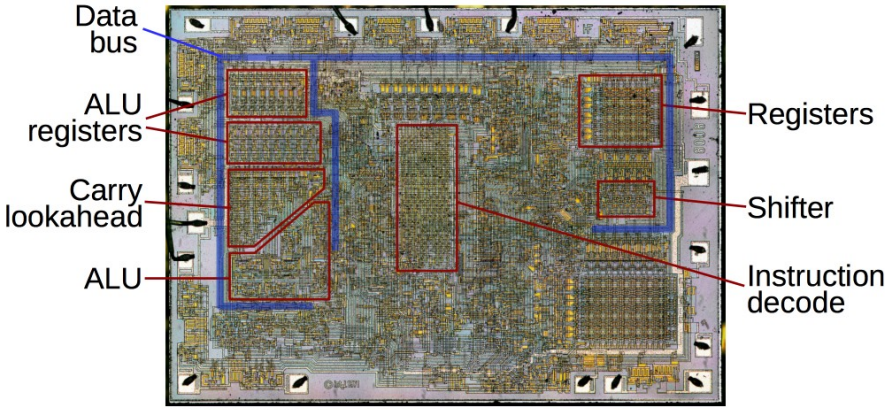


Evolução dos Computadores

Mas como disso, fomos parar nisso.

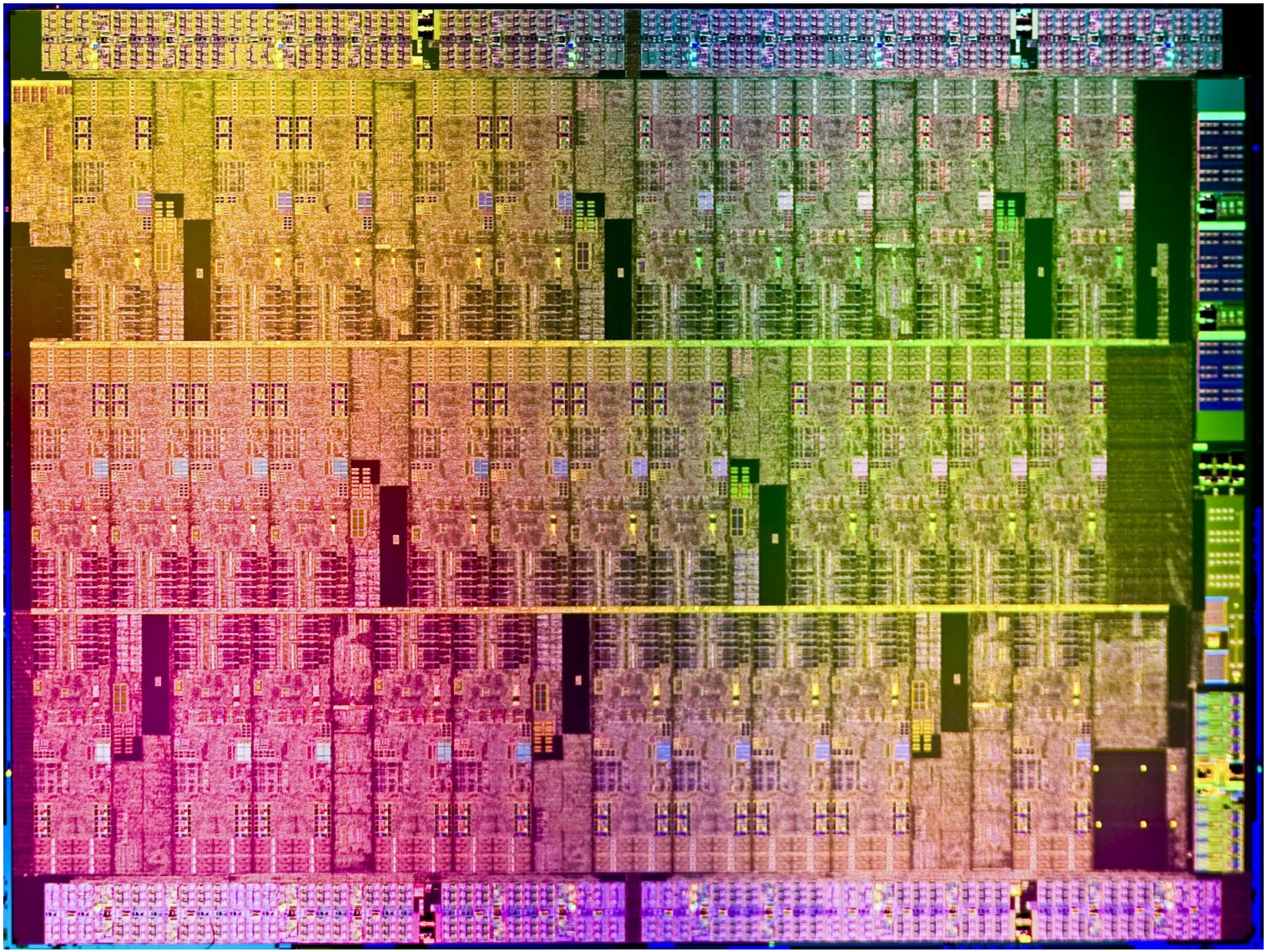
Primeiro transistor funcional
1947





8008 chip

Evolução !!!



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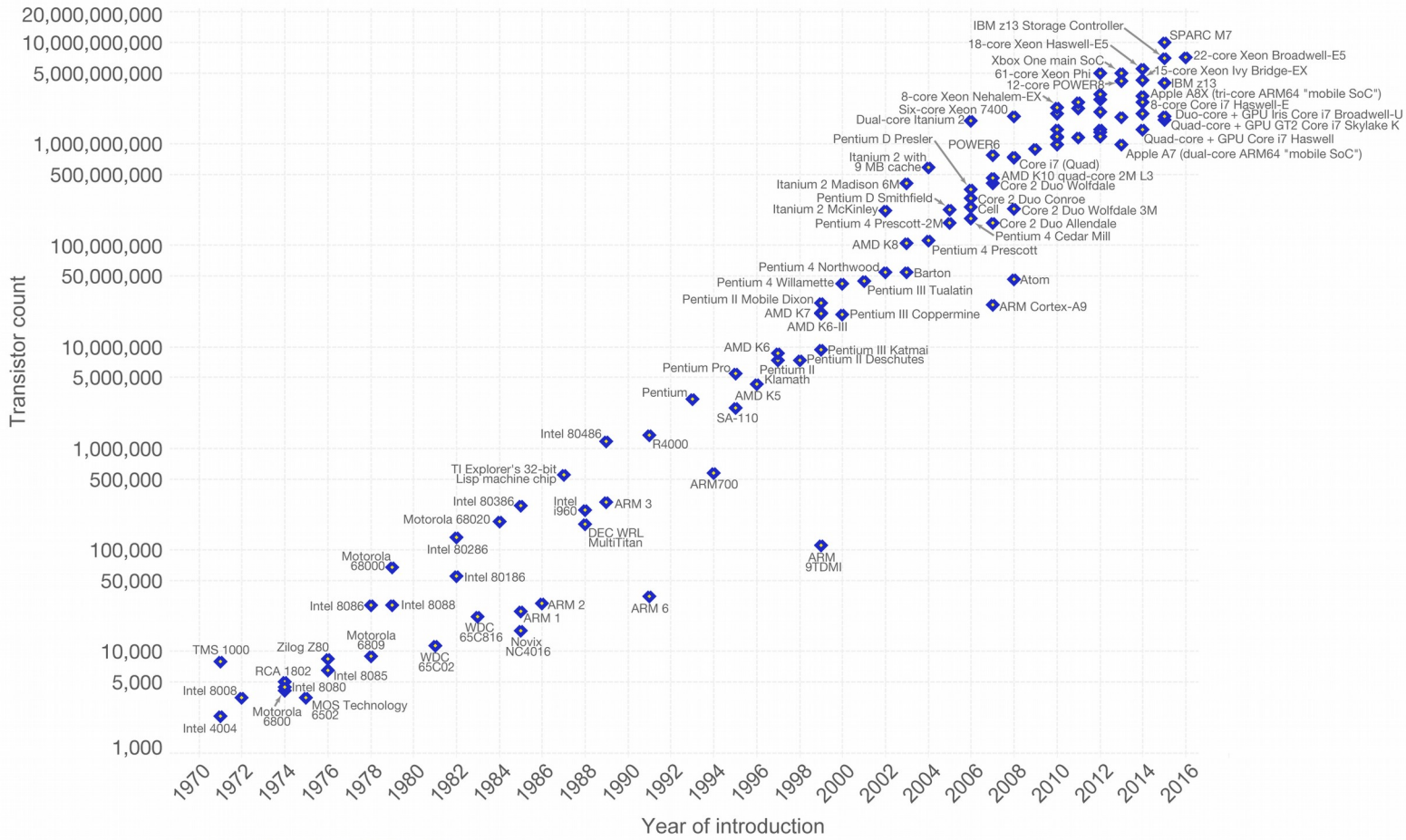
1965 – Lei de Moore

“ Moore's law is the observation that the number of transistors in a dense integrated circuit doubles approximately every two years. “

Moore’s Law – The number of transistors on integrated circuit chips (1971-2016)

Our World in Data

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important as other aspects of technological progress – such as processing speed or the price of electronic products – are strongly linked to Moore's law.



Data source: Wikipedia (https://en.wikipedia.org/wiki/Transistor_count)

The data visualization is available at OurWorldinData.org. There you find more visualizations and research on this topic.

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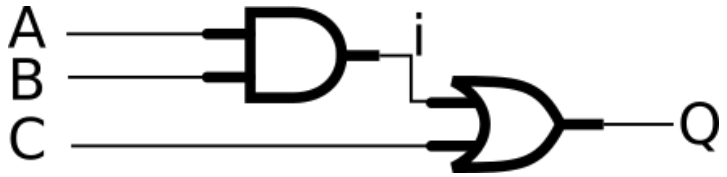
Da equação para implementação

- Vamos partir da equação :
  - `Q = (A.B) + C`
- Podemos escrever como :
  - `Q =(A and B) or C`
- Que por sua vez pode ser :
  - `I = (A and B)`
  - `Q = I or C`



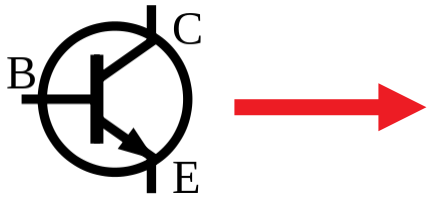
Mas do que é feito uma porta lógica ?

Transistores

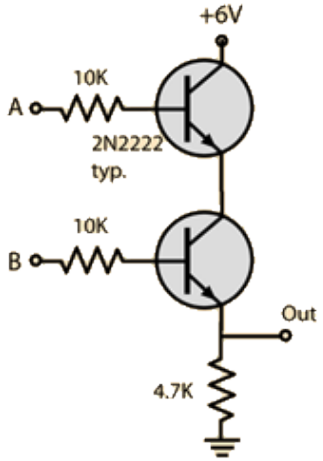
- Podemos implementar diversas portas lógicas
- Vários tipos de transistores
  - BJT
  - MOSFET
  - ….
- Várias maneiras de implementar
  - RTL
  - DTL
  - TTL
  - CMOS (mais utilizada hoje em dia)

RTL

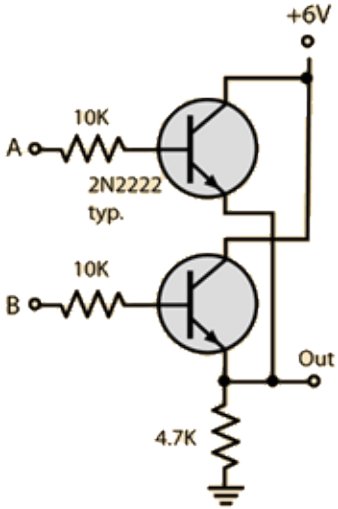
- A implementação de portas lógicas por RTL faz uso de transistores BJT do tipo N e resistores:



BJT

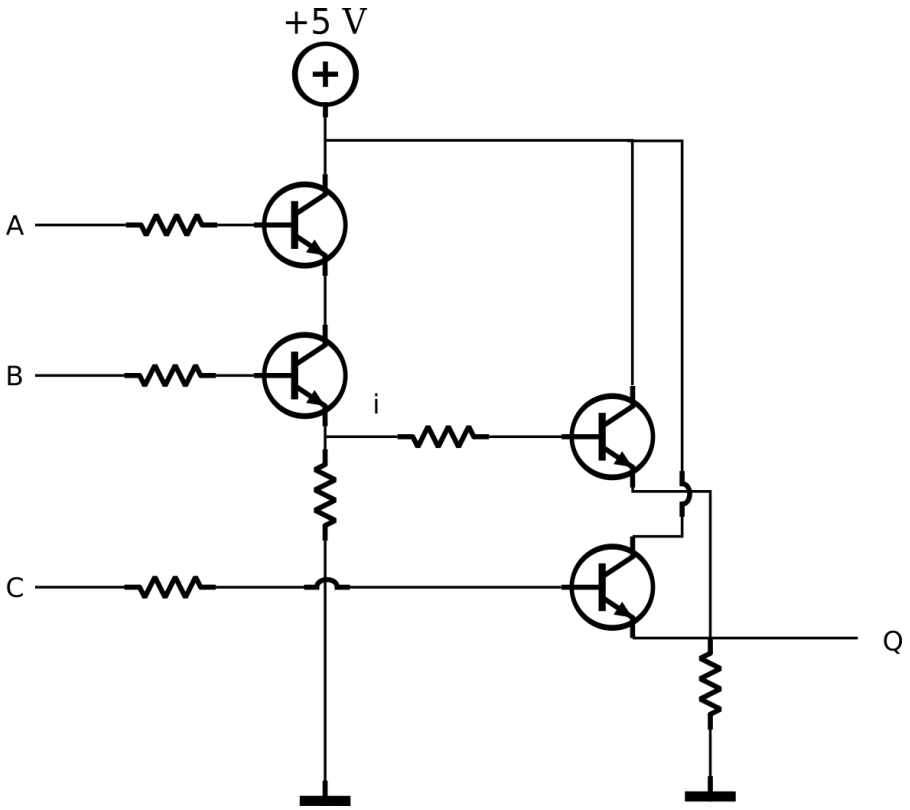


AND



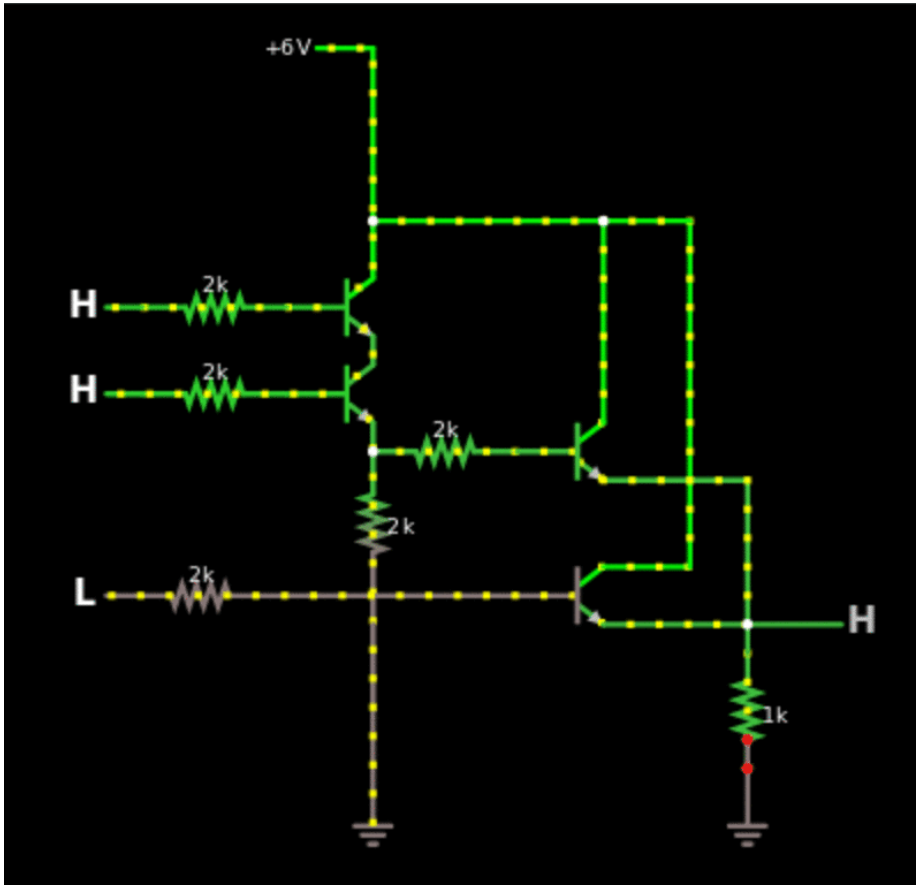
OR

Q = (A.B) + C



Simule :

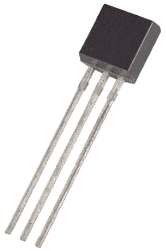
- http://www.falstad.com/circuit
- file → import from file
  - circuit_exe1.txt

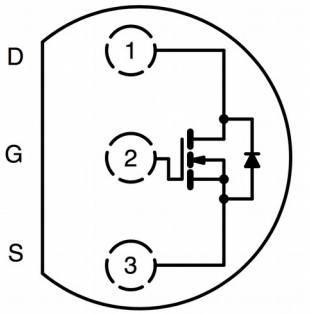


Problema com o BJT

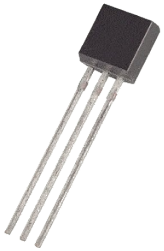
- Necessita de resistores
- Maior gasto energético durante condução
- Opera por corrente

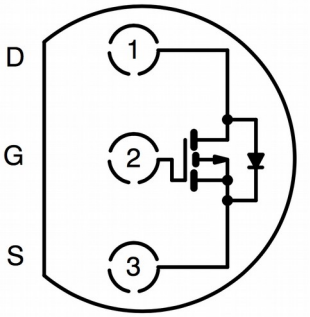
Transistores MOSFET





Vista Superior





Vista Superior

Handouts AULA 3

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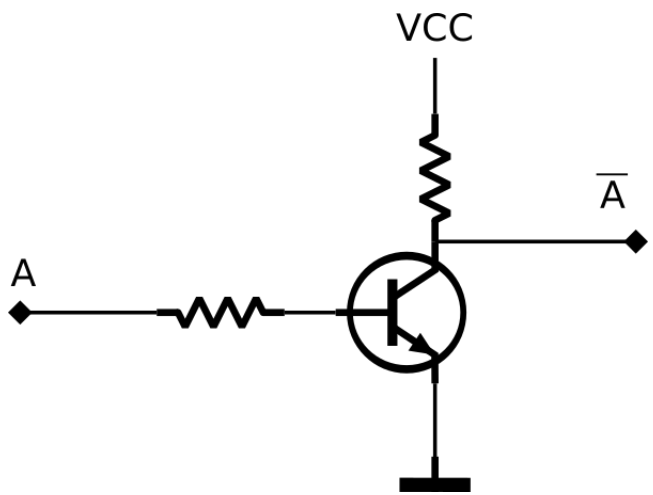
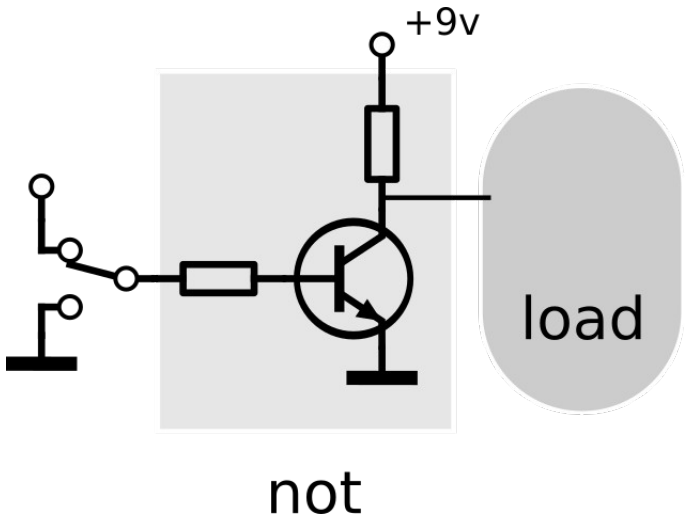
1a – RTL NOT



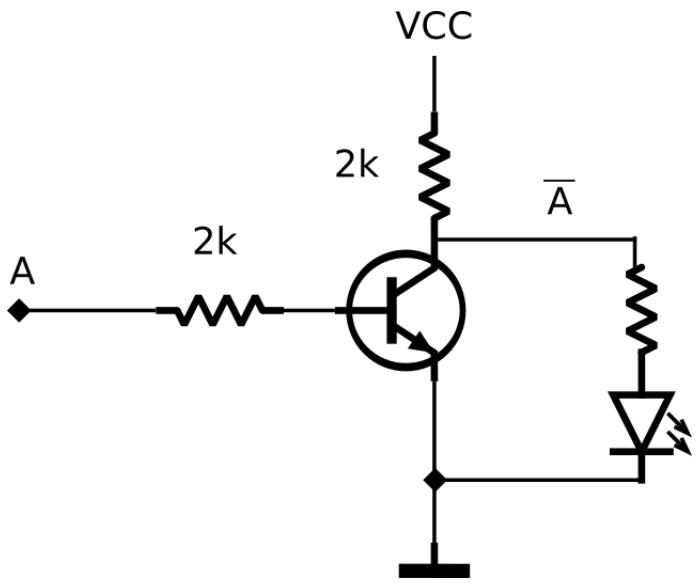
- Cada grupo deve implementar **duas** portas **NOT** e validar de forma independente.

1a – RTL NOT

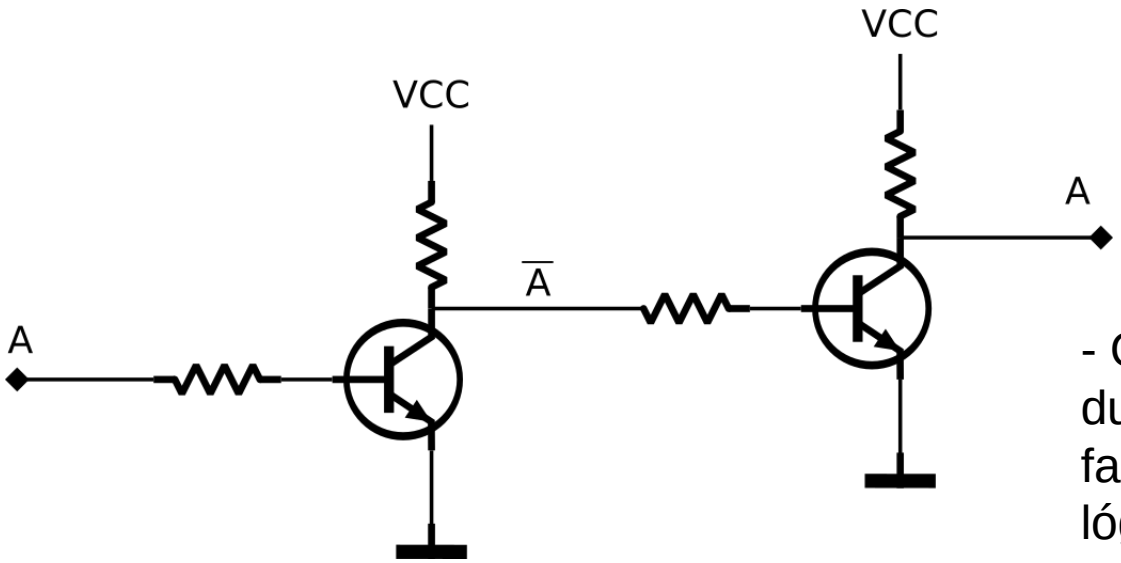


- Cada grupo deve implementar **duas** portas **NOT** e validar de forma independente.

1a – Testando com LED



1b – RTL NOT NOT



- Os grupos devem juntar as duas portas recém criadas para fazerem a seguinte equação lógica:

Q = not (not (A))

2 – Equação

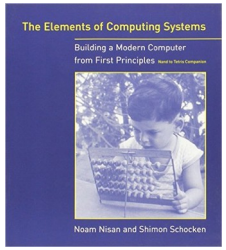
- Implemente a equação em transistores com a tecnologia RTL :

  - Q = A.(A.(A.B) + A.C)

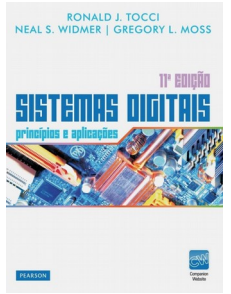
Próxima Aula

- Ver estudo para aula 8 sobre **Lógica Sequencial**
- Estudar Lista de Exercícios Aula 7 (opcional):
- Ler (opcional)

The Elements of Computing Systems
Building a Modern Computer from First Principles
Noam Nisan e Shimon Schocken
Capítulo 3



Sistemas Digitais - Princípios e Aplicações
Ronald Tocci, Neal Widmer e Gregory Moss
Capítulo 5



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