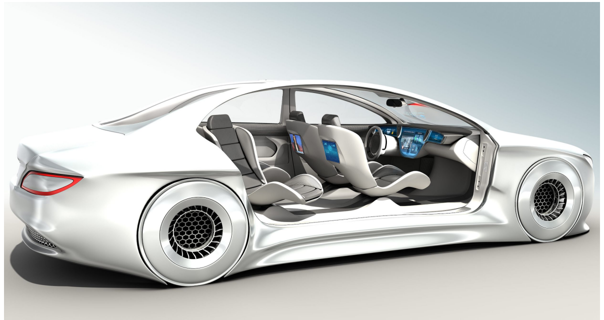
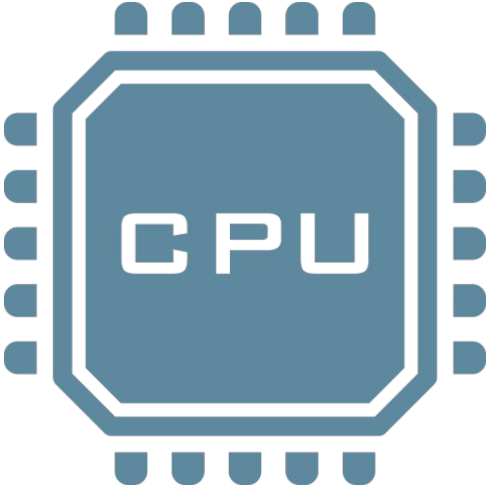
Sıfırdan Bire

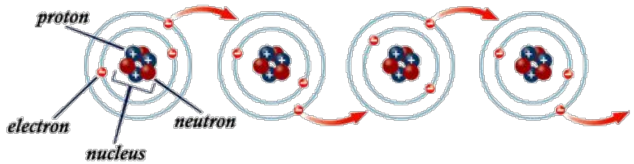
Suhap SAHIN

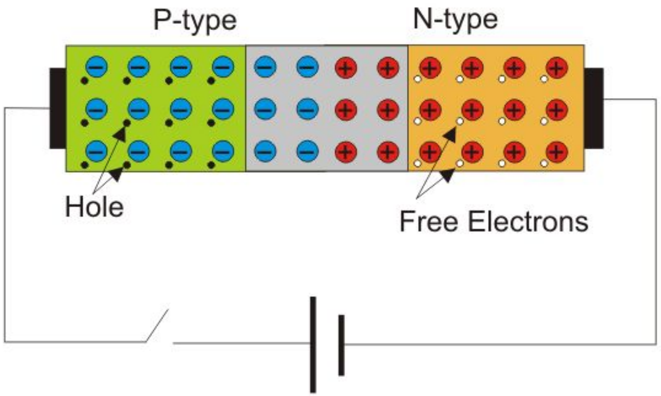
1.1 Mikroislemci Gelisiminin Önemi

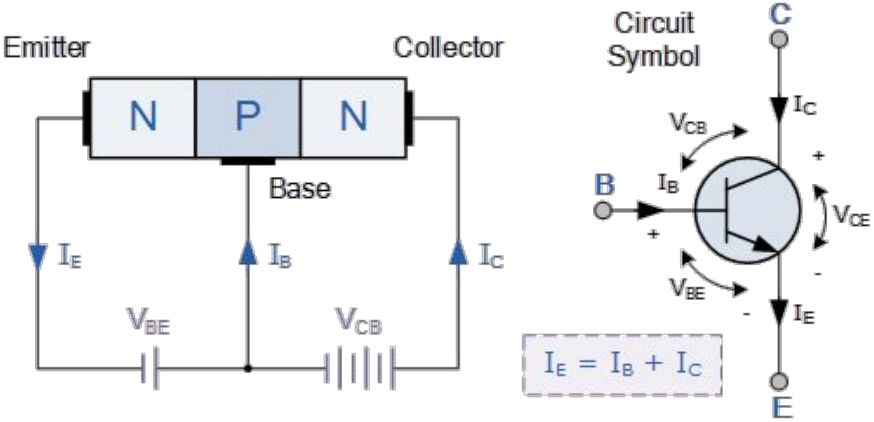




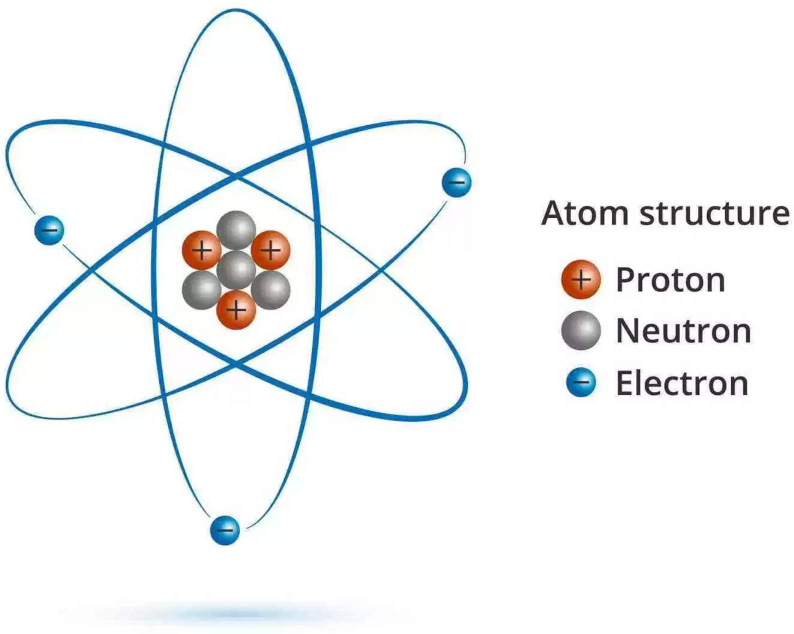
1.2 Karmasıklık Yönetimi







1.2.1 Soyutlama



QUANTUM MECHANICS

Maxwell's Equations

Differential form

$$\nabla \cdot \vec{E} = \frac{\rho}{\varepsilon_0}$$

$$\nabla \times \vec{E} = \boxed{-\frac{\partial \vec{B}}{\partial t}}$$

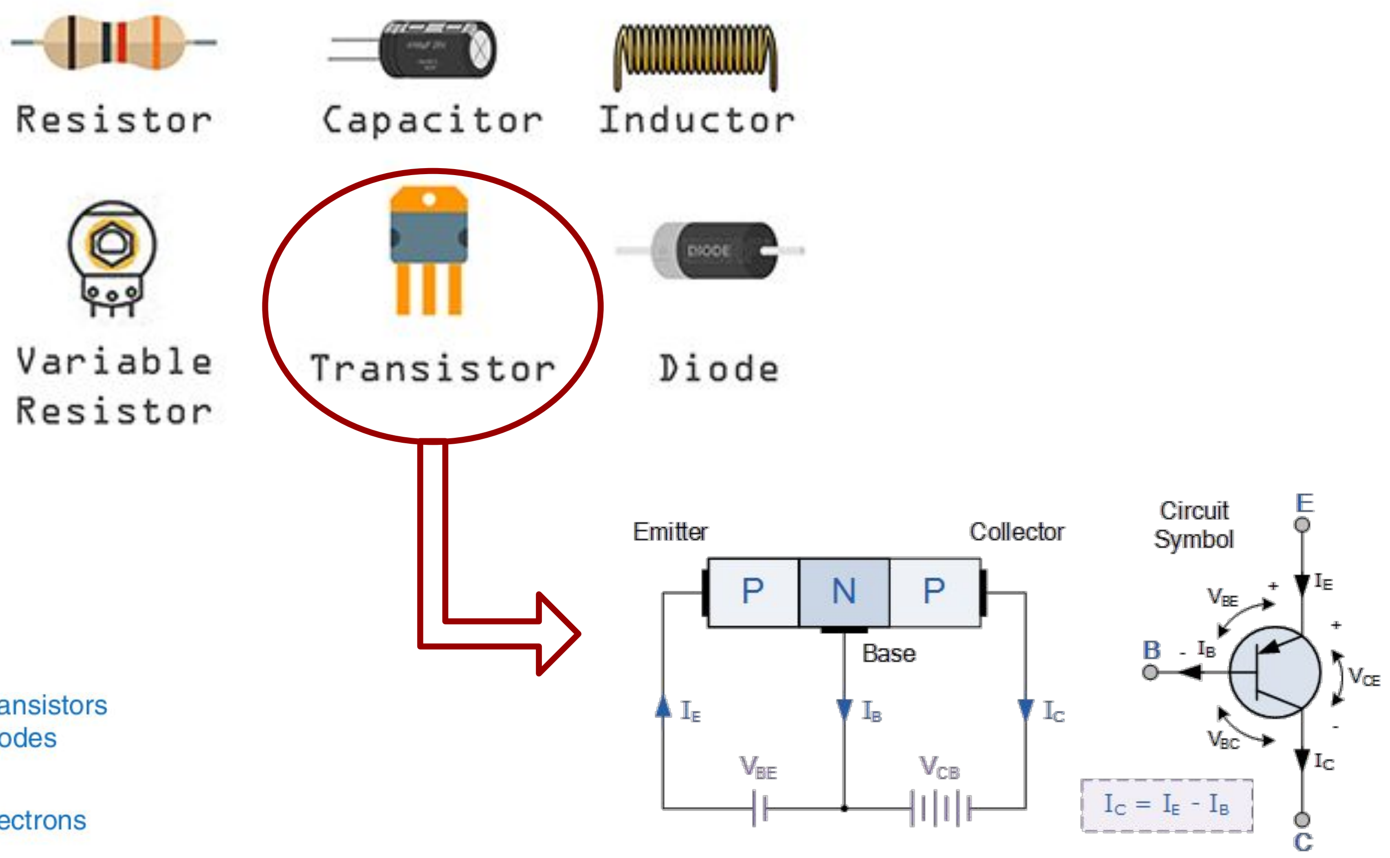
$$\nabla \cdot \vec{B} = 0$$

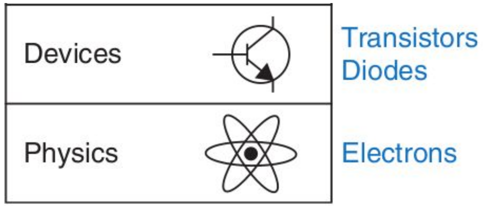
$$\nabla \times \vec{B} = \mu_0 \vec{J} + \boxed{\mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t}}$$

Physics

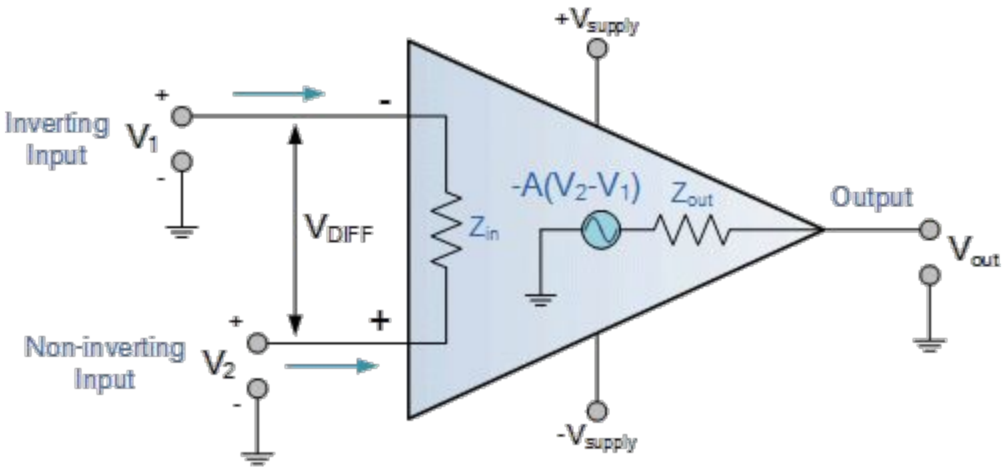
Electrons

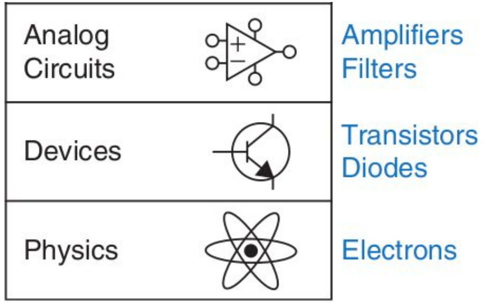
1.2.1 Soyutlama



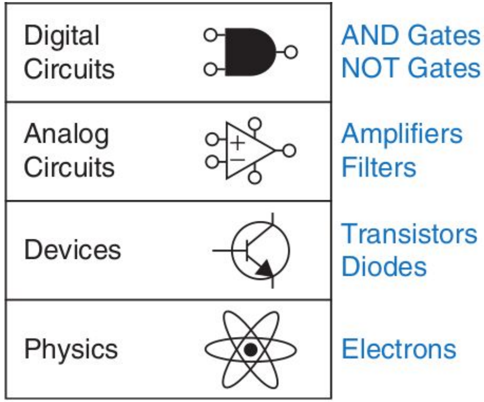


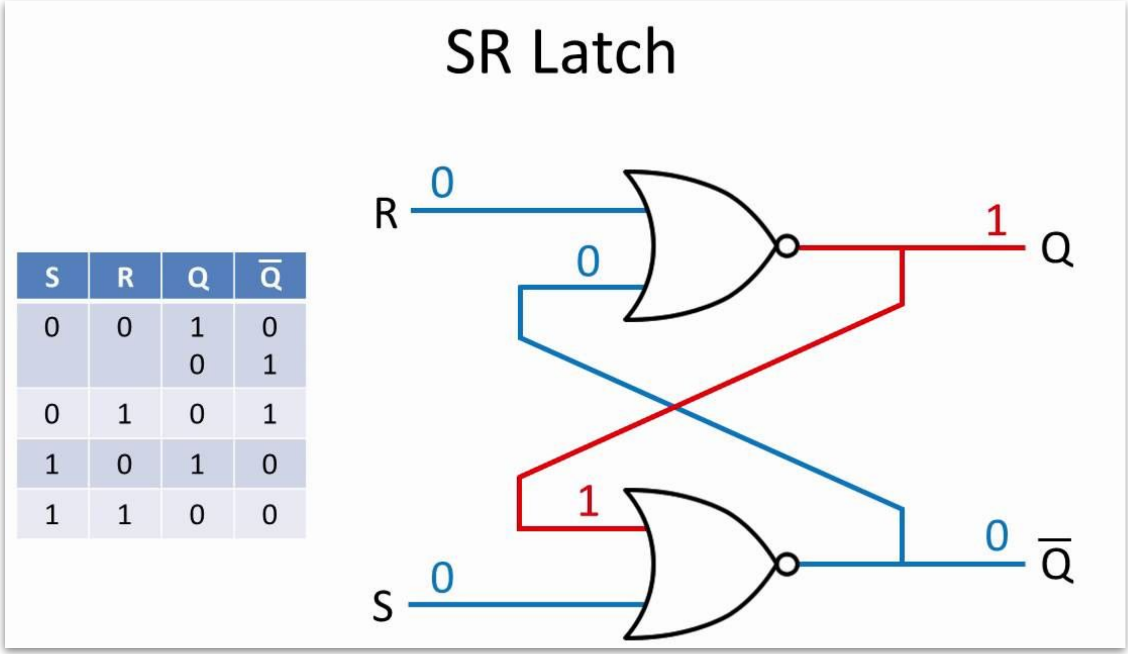
1.2.1 Soyutlama





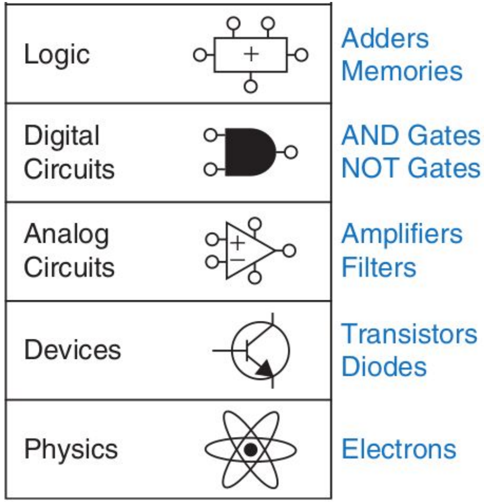
1.2.1 Soyutlama

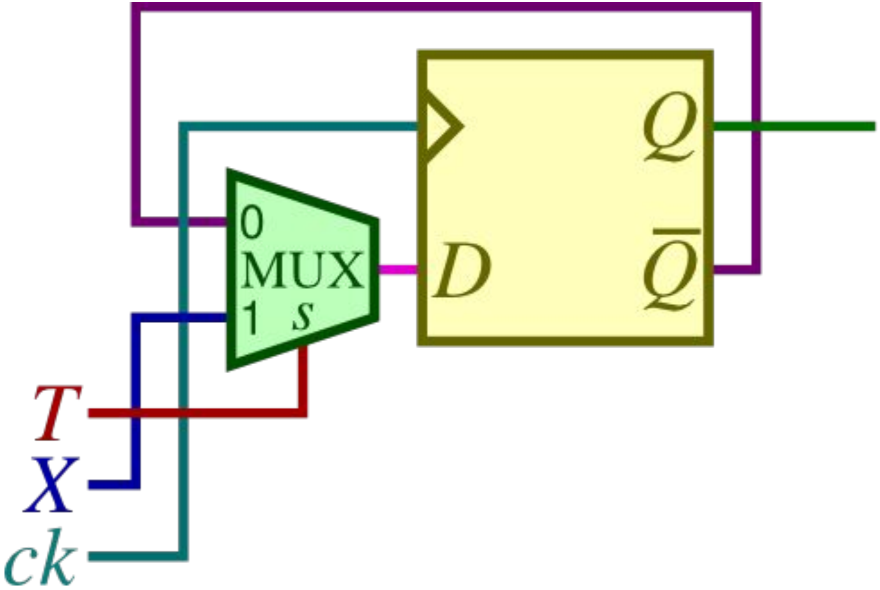




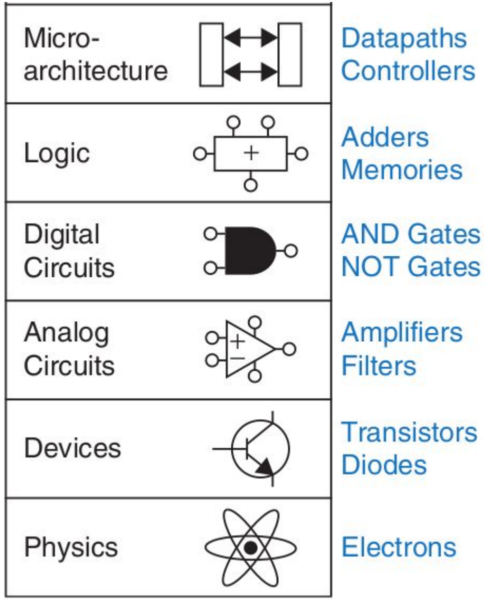
S	R	Q	$\overline{Q}$
0	0	1 0	0 1
0	1	0	1
1	0	1	0
1	1	0	0

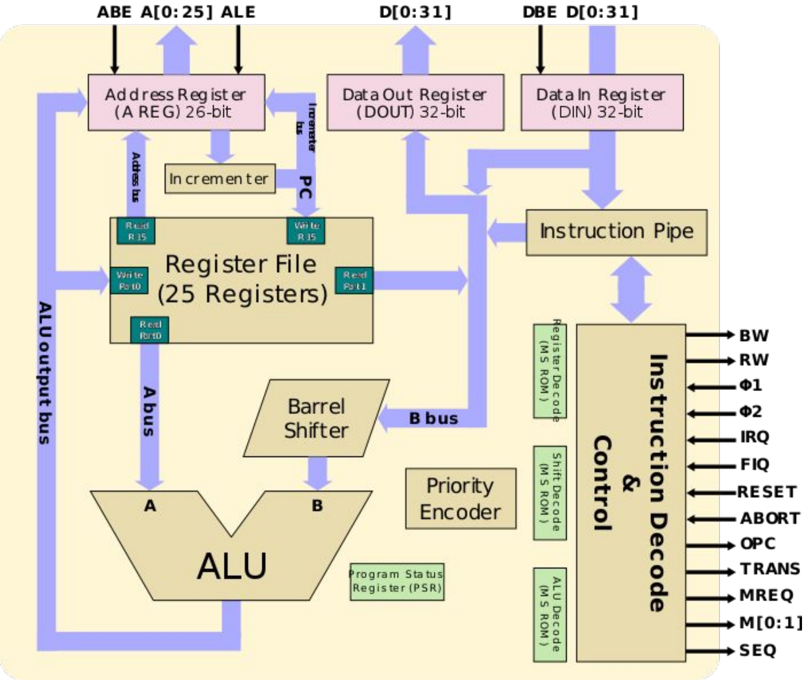
1.2.1 Soyutlama



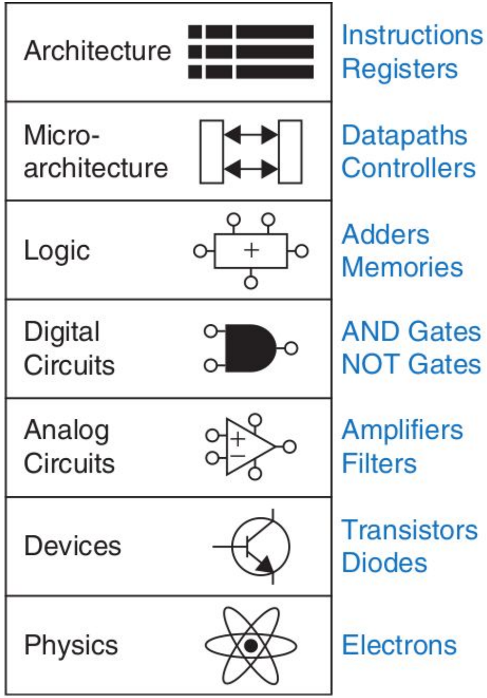


1.2.1 Soyutlama





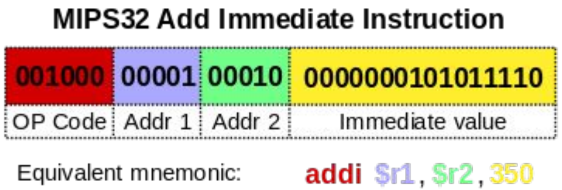
1.2.1 Soyutlama



MIPS32 Instruction Set

Instructions that machine executes

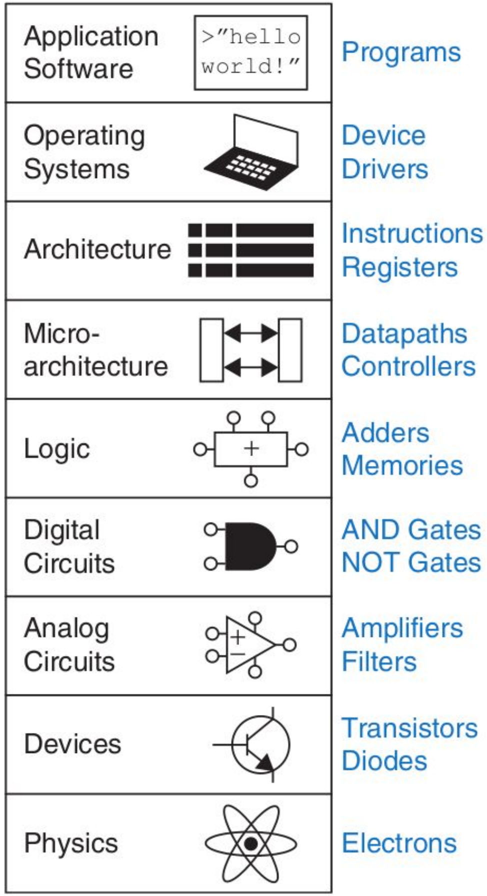
```
blez  $a2, done
move  $a7, $zero
li    $t4, 99
move  $a4, $a1
move  $v1, $zero
li    $a3, 99
lw    $a5, 0($a4)
addiu $a4, $a4, 4
slt   $a6, $a5, $a3
movn  $v0, $v1, $a6
addiu $v1, $v1, 1
movn  $a3, $a5, $a6
```

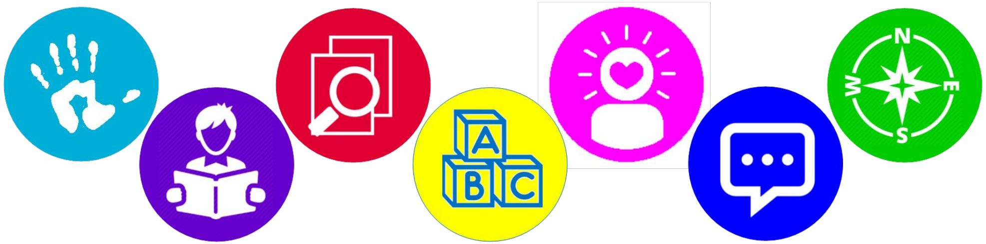


1.2.1 Soyutlama

Operating Systems	Device Drivers
Architecture	Instructions Registers
Micro-architecture	Datapaths Controllers
Logic	Adders Memories
Digital Circuits	AND Gates NOT Gates
Analog Circuits	Amplifiers Filters
Devices	Transistors Diodes
Physics	Electrons

1.2.1 Soyutlama

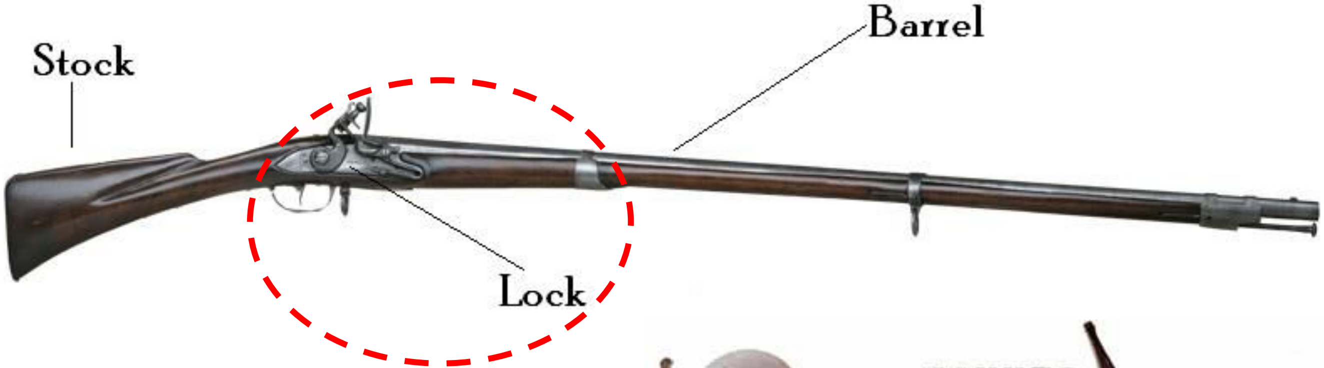




1.2.2 Disiplin

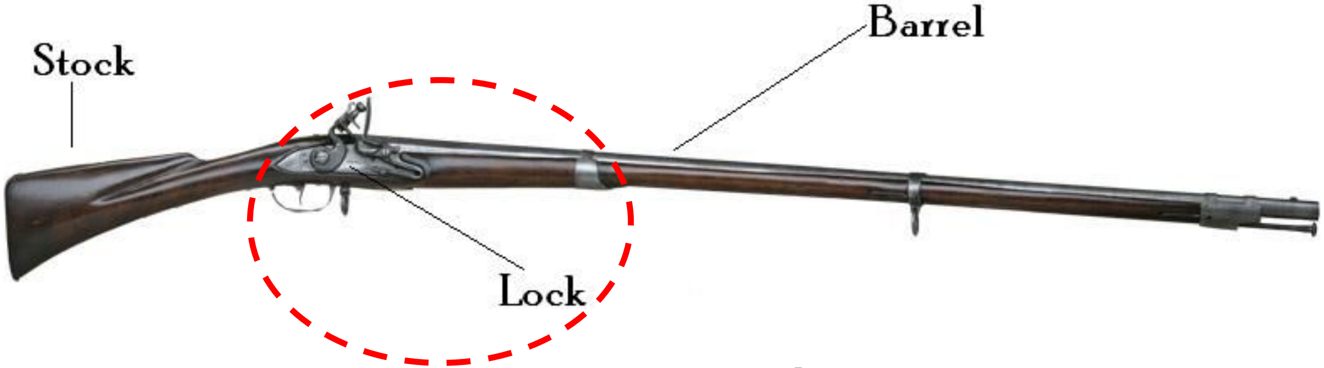
1.2.3 Karmasıklık için Üc Y

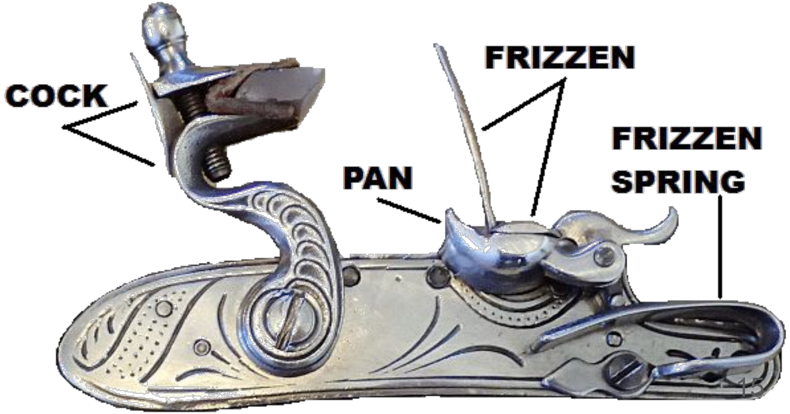
Hierarchy



1.2.3 Karmasıklık için Üc Y

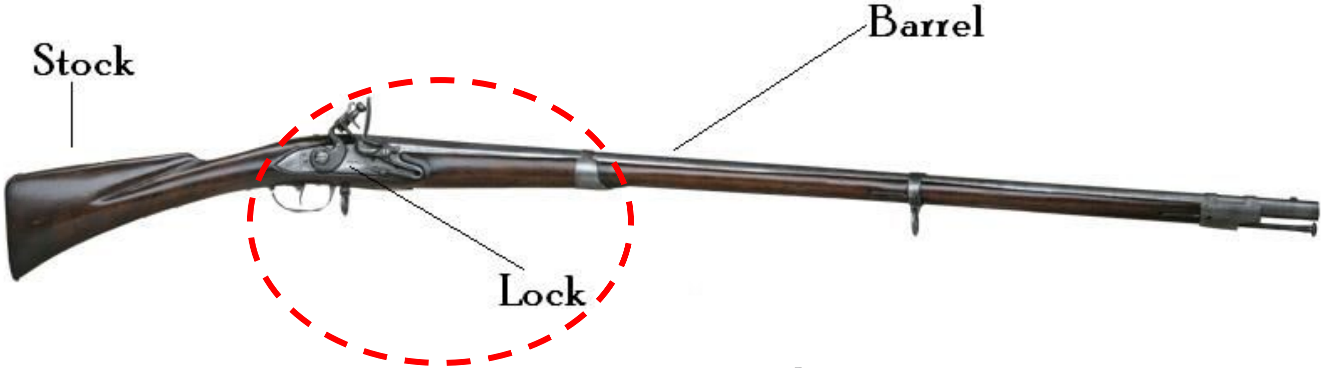
Modularity

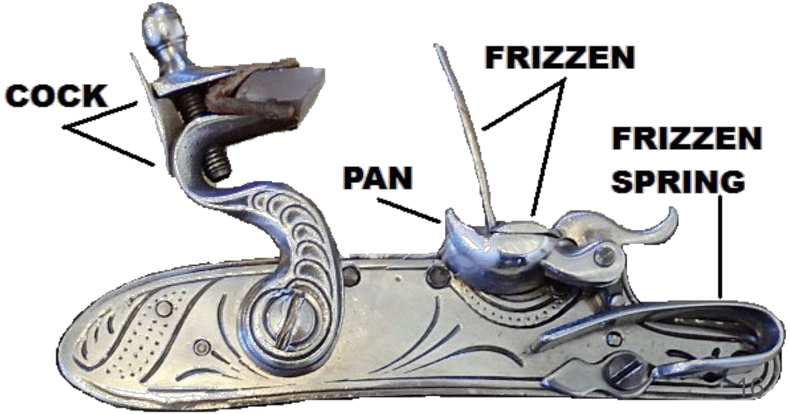




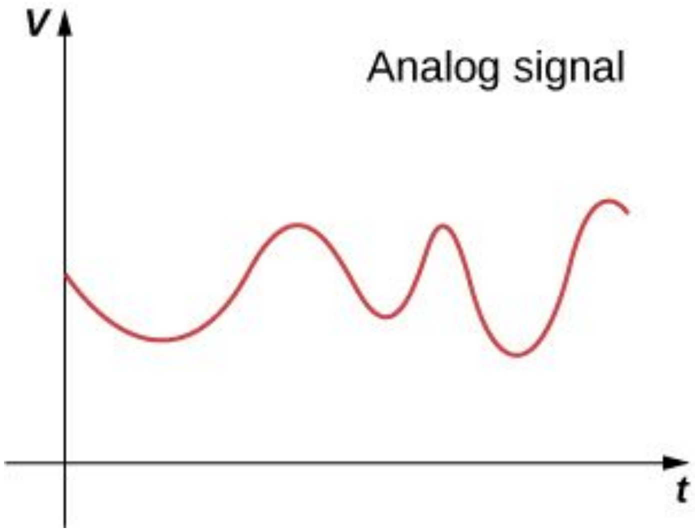
1.2.3 Karmasıklık için Üc Y

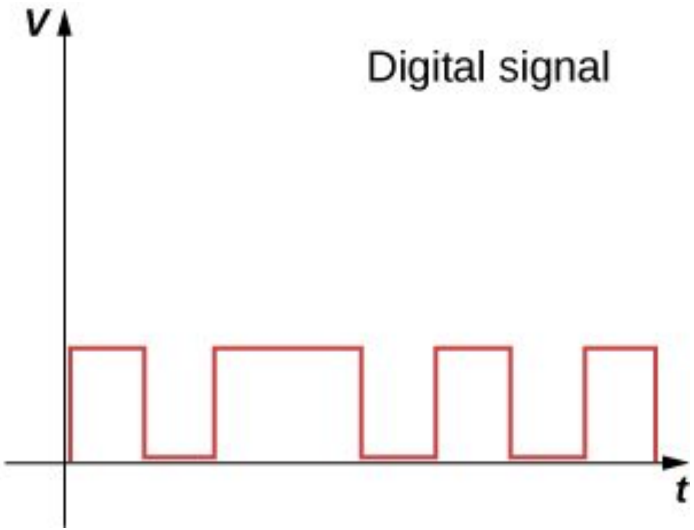
Regularity



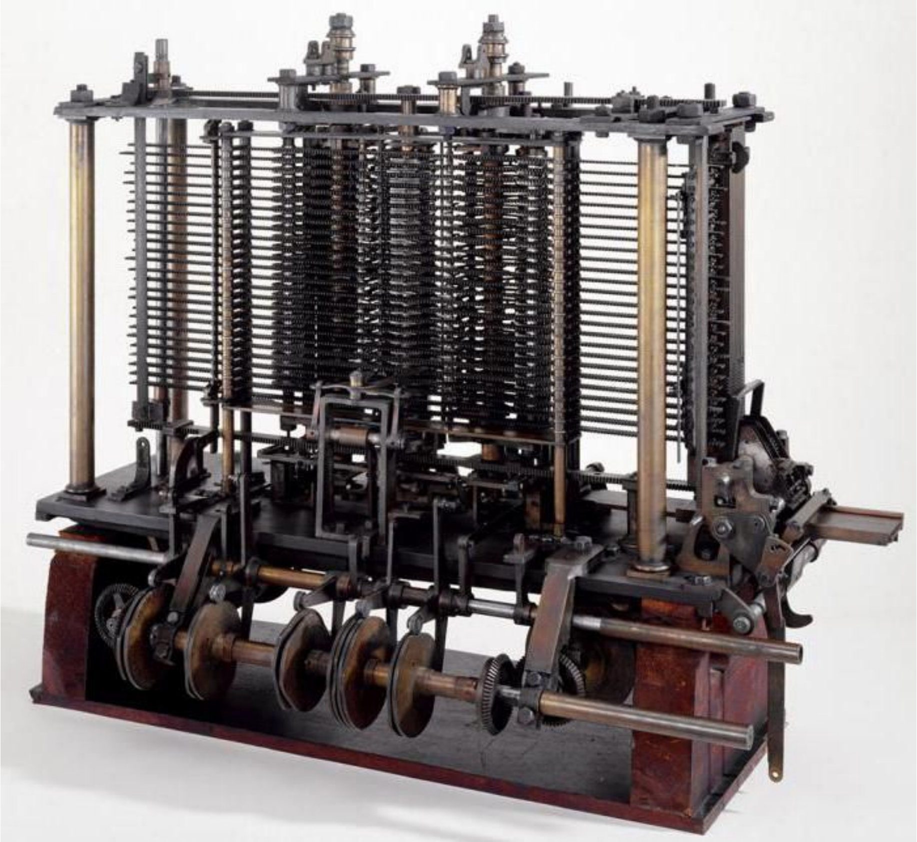


1.3 Sayısal Soyutlama





1.3 Sayısal Soyutlama

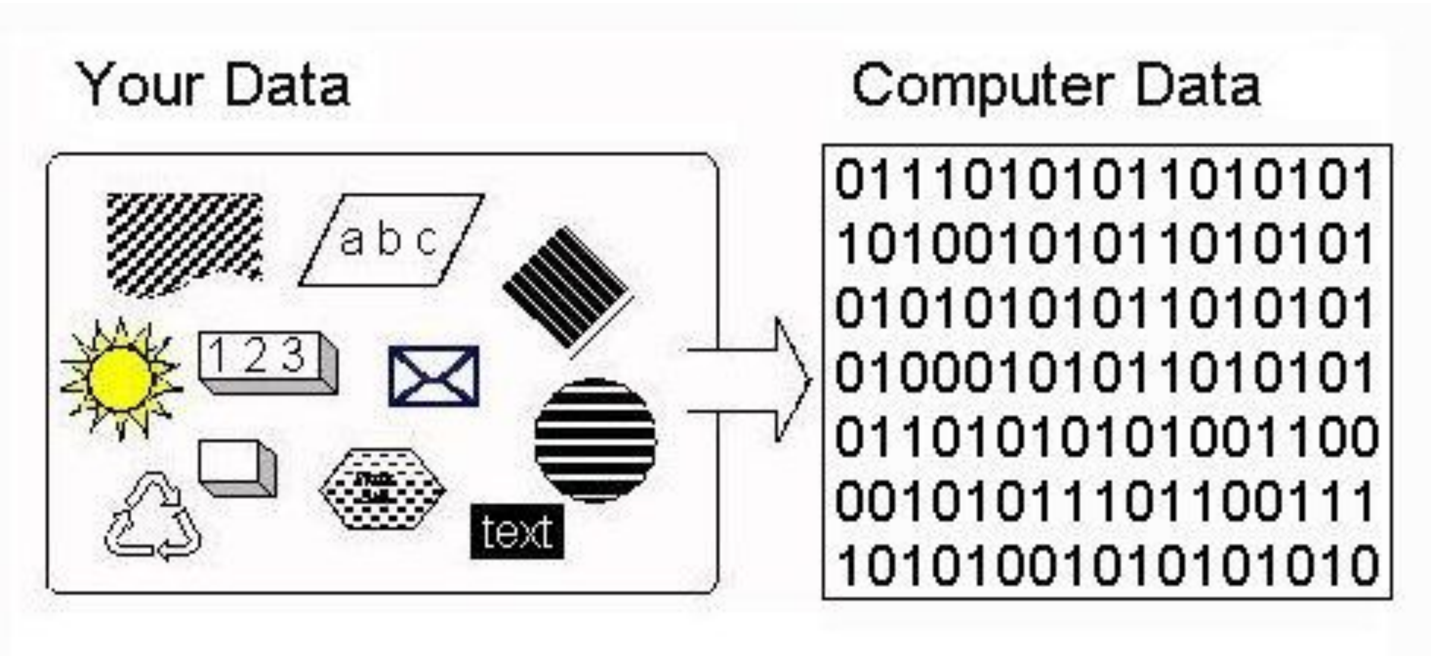


Charles Babbage, 1791-1871
Analytical Engine

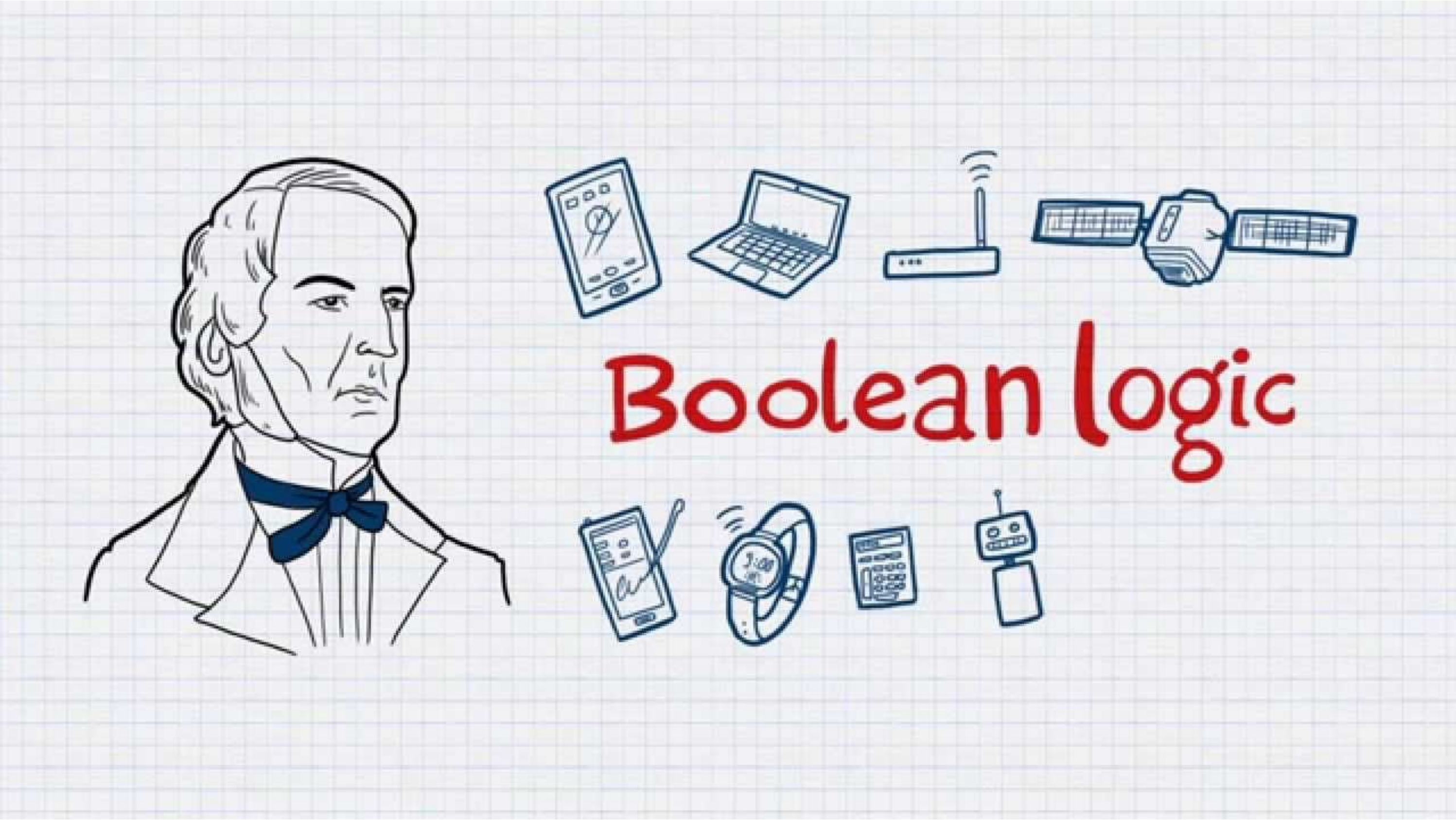
O dan 9 kadar konumlanan disliler

Her bir satır bir basamak
Makinede 25 satır var

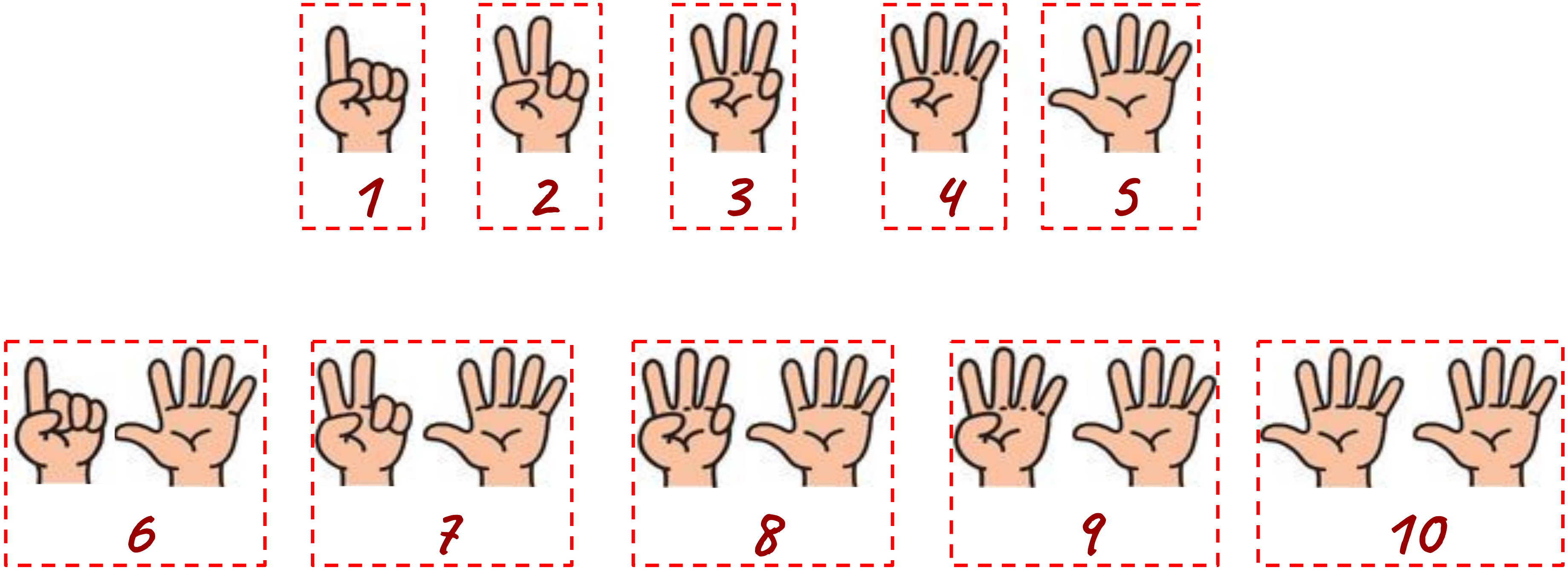
1.3 Sayısal Soyutlama



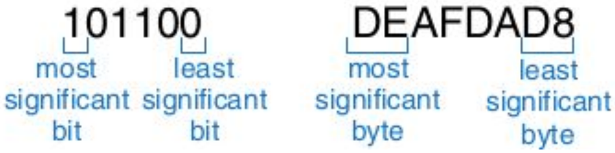
1.3 Sayısal Soyutlama



1.4.1 Onluk Sayı Sistemi



1.4.2 ikilik Sistemi



$84_{10} = (?)_2$

$84_{10} = (1010100)_2$

$84 \geq 64$	1
$20 < 32$	0
$20 \geq 16$	1
$4 < 8$	0
$4 \geq 4$	1
$0 < 2$	0
$0 < 1$	0

1.4.3 Onaltılık Sayı Sistemi

Hexadecimal Sayı Sistemi

256's column
16's column
1's column

$$2ED_{16} = 2 \times 16^2 + E \times 16^1 + D \times 16^0 = 749_{10}$$

two two hundred fifty six's

fourteen sixteens

thirteen ones

Hexadecimal Digit	Decimal Equivalent	Binary Equivalent
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
A	10	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111

1.4.3 Onaltılık Sayı Sistemi

Hexadecimal
Sayı Sistemi

$(1111010)_2 = (?)_{16}$

$(1111010)_2 = (0111\ 1010)_2$

$(0111\ 1010)_2 = (7A)_{16}$

1.4.3 Onaltılık Sayı Sistemi

Hexadecimal Sayı Sistemi

$333_{10} = (?)_{16}$

$333 \geq 256$	1
$77 < 16$	4
$13 \geq 1$	D

$333_{10} = (14D)_{16}$

1.4.4 Bytes, Nibbles

Byte : 8 bit

Nibble : 4 bit

Word : islemci mimarisine baglı

64 bit islemci → 64 bit word

1.4.4 Bytes, Nibbles

$2^{10} = 1024 \approx 10^3$

2^{10} (10^3) = 1 Kilobit (1KB)

2^{20} (10^6) = 1 Megabit (1MB)

2^{30} (10^9) = 1 Gigabit (1GB)

2^{24}	=	?
2^{24}	=	$2^{20}\ 2^4$
$2^{20} \times 2^4$	=	2^4x 1 milyon
2^4x 1 milyon	=	16 milyon

1.4.5 ikilik Toplama

	11	← carries →	11
	4277		1011
+	5499	+	0011
	9776		1110

Tasma

$$
\begin{array}{r}
\color{blue}{11\ 1} \\
1101 \\
+\ \ 0101 \\
\hline
10010
\end{array}
$$

Tasma

1996 yılında fırlatılan Ariane 5 roketi(7 milyar dolar); fırlatılmasından 40 saniye sonra patladı.

Roketi kontrol eden bilgisayar 16 bitlik islem sınırını astı ve çöktü.

Aynı bilgiyarda aynı kod Ariane 4 roketi kullanılarak defalarça test edildi.

Ancak Ariane 5, daha hızlı bir motora sahipti

1.4.6 isaret/büyüklük sayıları

$+5_{10} = 0101_2$

$-5_{10} = 1101_2$

$\cancel{-5 + 5}$

$\cancel{= 110 \ldots 0101_2}$

$\cancel{= 1 \ldots 0010_2}$

$\cancel{-0_{10} = 1000_2}$ $+0_{10} = 0000_2$

2'ye tümleyen sayılar

$+2_{10} = 0010_2$

$-2_{10} = 0010_2$

$= 1101_2$

$= 1101_2 + 1_2$

$= 1110_2$

2'ye tümleyen sayılar

4bit isaretsiz sayılar

16 deger: 0 → 15

4bit ikiye tümleyen sayılar

16 deger: -8 → 7 (0 pozitif)

N bit ikiye tümleyen sayılar

2^N deger: $-2^{N-1} \rightarrow 2^{N-1} - 1$

toplama

$-2_{10} + 1_{10}$

$= 1110_2 + 0001_2$

$= 1111_2$

$= -1_{10}$

$-7_{10} + 7_{10}$

$= 1001_2 + 0111_2$

$= 10000_2$

$= 0000_2$

$= 0_{10}$

cikarma

$5_{10} - 3_{10}$

$= 5_2 + (-3_{10})$

$= 0101_2 + 1101_2$

$= 0010_{10}$

$= 2_2$

$+\ 3_{10} = 0011_2$

$1100_2 + 0001_2$

$-\ 3_{10} = 1101_2$

Tasma

Pozitif + Pozitif = Negatif
Negatif + Negatif = Pozitif

Tasma

4bit ikiye tümleyen sayılar

16 deger: -8 → 7 (0 pozitif)

$+4_{10} + 5_{10}$

$= 0100_2 + 0101_2$

$= 1001_2$

$= -7_{10}$

isaret düzenleme

$+3_{10} = 0011_2$

$-3_{10} = 1101_2$

$+3_{10} = 000011_2$

$-3_{10} = 111101_2$

Karsılastırma

System	Range
Unsigned	$[0, 2^N - 1]$
Sign/Magnitude	$[-2^{N-1} + 1, 2^{N-1} - 1]$
Two's Complement	$[-2^{N-1}, 2^{N-1} - 1]$

Karsılastırma

	−8	−7	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Unsigned									0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
Two's Complement	1000	1001	1010	1011	1100	1101	1110	1111	0000	0001	0010	0011	0100	0101	0110	0111								
Sign/Magnitude		1111	1110	1101	1100	1011	1010	1001	0000 1000	0001	0010	0011	0100	0101	0110	0111								

weird number

Lojik Kapılar

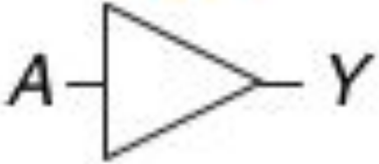
NOT

$$Y = \overline{A}$$

A	Y
0	1
1	0

Lojik Kapılar

BUF



$$Y = A$$

A	Y
0	0
1	1

Lojik Kapılar

AND

$$Y = AB$$

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

Lojik Kapılar

OR

$$Y = A + B$$

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Lojik Kapılar

XOR

$Y = A \oplus B$

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

NAND

$Y = \overline{AB}$

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

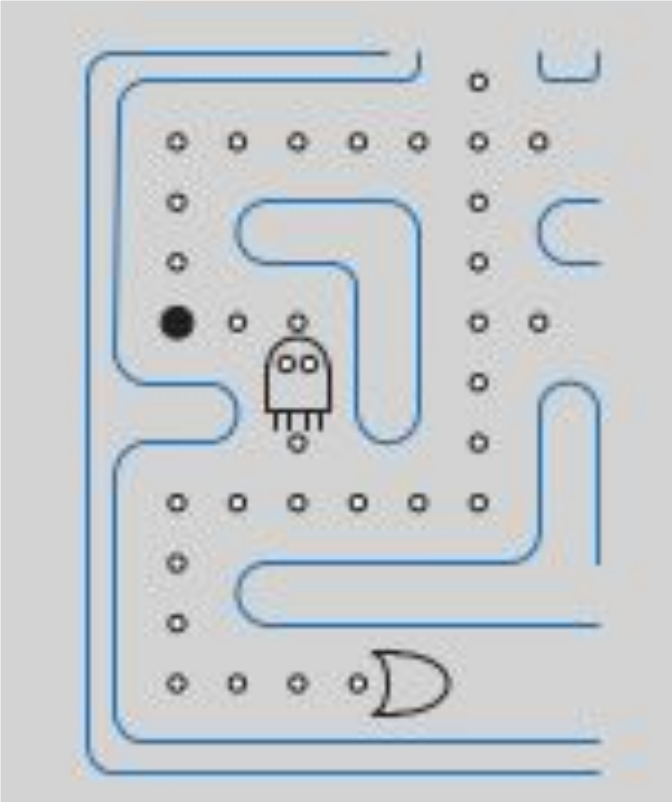
NOR

$Y = \overline{A + B}$

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Lojik Kapılar

A silly way to remember the OR symbol is that its input side is curved like Pacman's mouth, so the gate is hungry and willing to eat any TRUE inputs it can find!



Lojik Kapılar

XNOR

$Y = \overline{A \oplus B}$

A	B	Y
0	0	
0	1	
1	0	
1	1	

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

Lojik Kapılar

NOR3

$$Y = \overline{A + B + C}$$

A	B	C	Y
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

A	B	C	Y
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

Dijital Soyutlamaya yakından bakıs

0 V --> A = 0 ; 5 V --> A = 1 olarak yorumlansın

Sistemler az miktarda gürültüyü tolere edebilirler:

4.97 V--> A = 1 olarak yorumlanır.

Ancak

4.3 V?

2.8 V?

2.500000 V?

Besleme Gerilimi

Sistemdeki en düsük voltaj, toprak(GND)= 0 V

Sistemdeki en yüksek voltaj,VDD=(1970 &1980) =5V

Transistörler küçükdükçe(güç tasarrufu ve asırı yüklenme);
VDD= 3.3 V, 2.5 V, 1.8 V, 1.5 V, 1.2 V düstü.

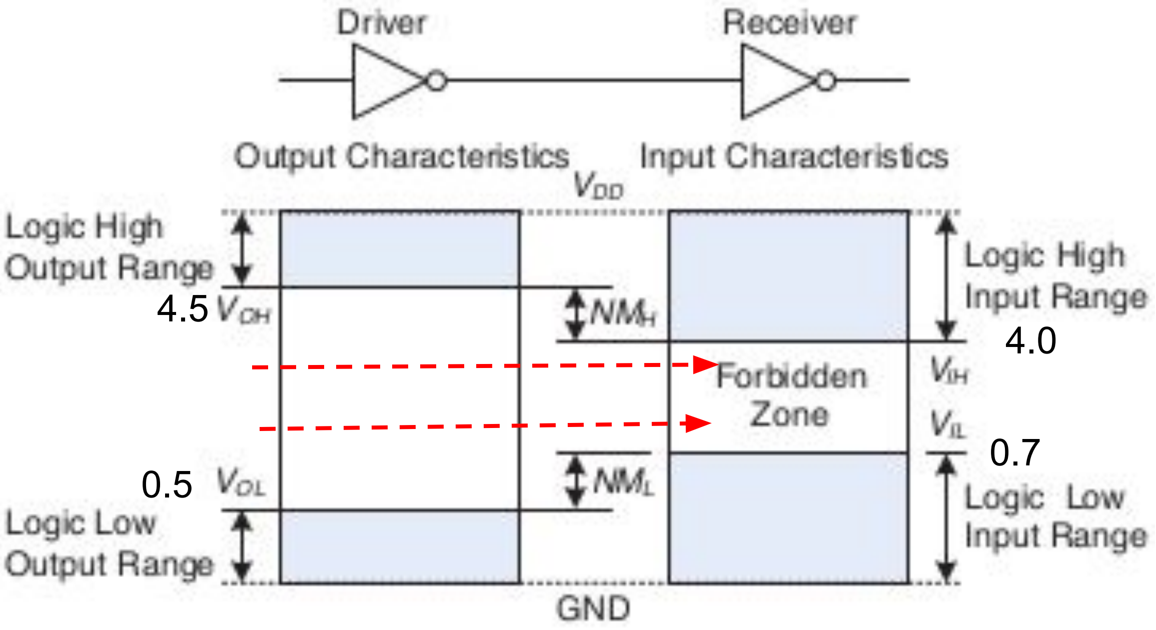
Lojik Seviye

$V_{OL} < V_{IL}$

$V_{OH} > V_{IH}$

$$NM_L = V_{IL} - V_{OL}$$

$$NM_H = V_{OH} - V_{IH}$$



Gürültü Aralıgı

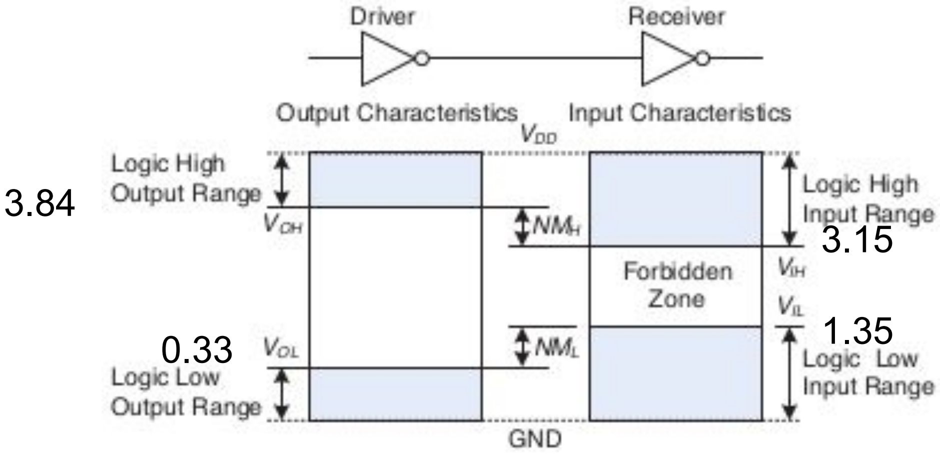
Interterlerin en yüksek ve en düsük gürültü sınırı nedir?

Devre V_{O1} ve V_{I2} arasındaki 1V'luk gürültüyü tolere edebilir mi?

V_{DD} = 5V
V_{IL} = 1.35V
V_{IH} = 3.15V
V_{OL} = 0.33V
V_{OH} = 3.84V

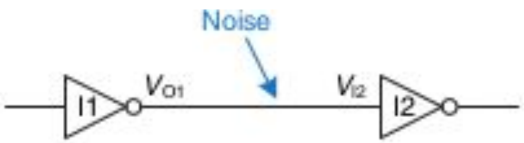
$$NM_L = V_{IL} - V_{OL}$$

$$NM_H = V_{OH} - V_{IH}$$



Gürültü Aralığı

Interterlerin en yüksek ve en düsük gürültü sınırı nedir?



$V_{DD} = 5V$

$V_{IL} = 1.35V$

$V_{IH} = 3.15V$

$V_{OL} = 0.33V$

$V_{OH} = 3.84V$

$NM_L = V_{IL} - V_{OL}$

$= 1.35V - 0.33V$

$= 1.02V$

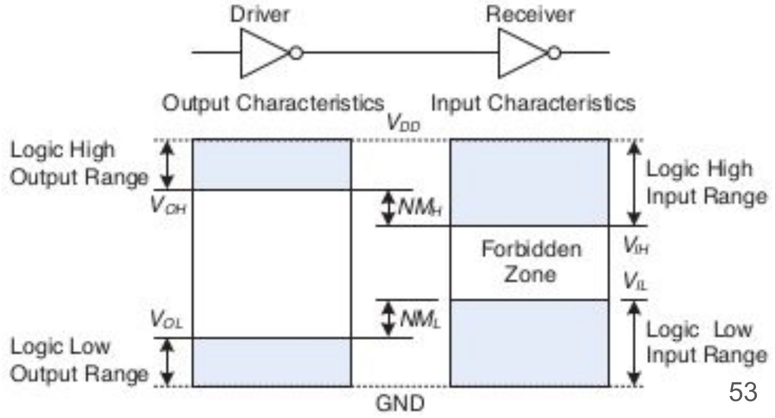
$NM_H = V_{OH} - V_{IH}$

$= 3.84V - 3.15V$

$= 0.69V$

$$NM_L = V_{IL} - V_{OL}$$

$$NM_H = V_{OH} - V_{IH}$$



Lojik Seviye- Gürültü Aralıgı

Interterlerin en yüksek ve en düsük gürültü sınırı nedir?

Devre V_{O1} ve V_{I2} arasındaki 1V'luk gürültüyü tolere edebilir mi?

V_{DD}= 5V

V_{IL} = 1.35V

V_{IH}= 3.15V

V_{OL}= 0.33V

V_{OH}= 3.84V

LOW

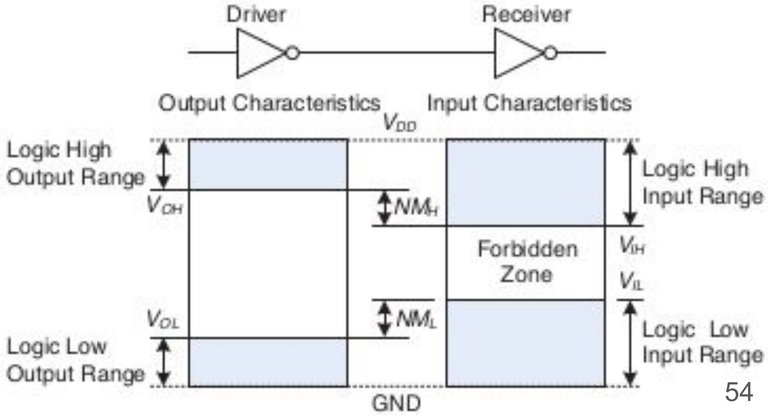
NM_L= 1.02V

HIGH

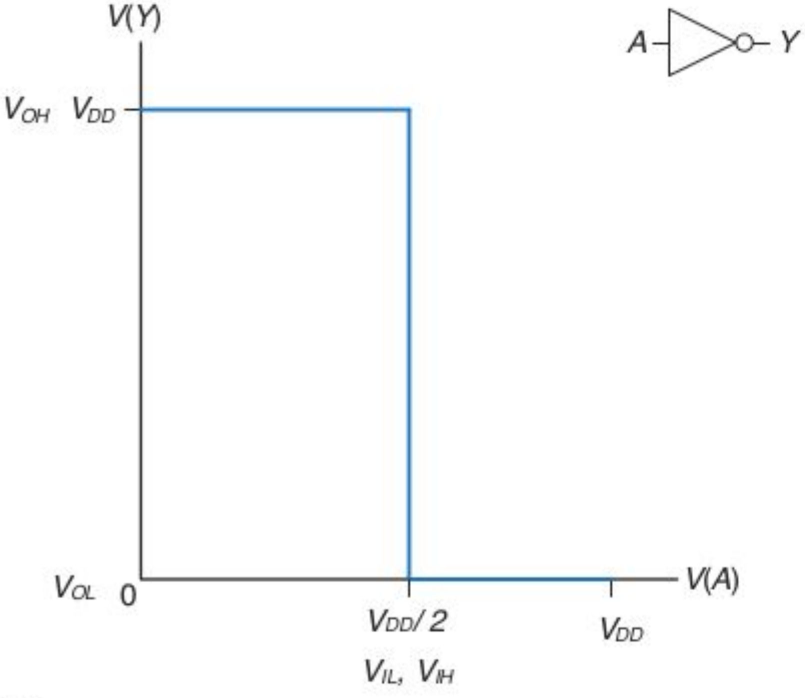
NM_H= 0.69V

$$NM_L = V_{IL} - V_{OL}$$

$$NM_H = V_{OH} - V_{IH}$$



DC iletim karakteristigi



$V(A) < V_{DD}/2 \Rightarrow V(Y) = V_{DD}$

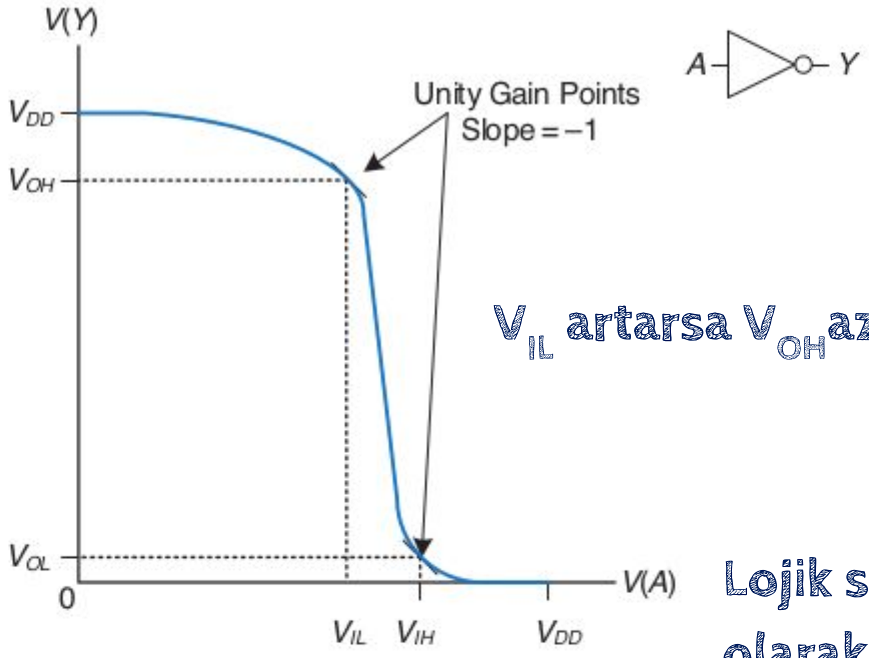
$V(A) > V_{DD}/2 \Rightarrow V(Y) = 0$

$V_{IL} = V_{IH} = V_{DD}/2$

$V_{OH} = V_{DD}$

$V_{OL} = 0$

DC iletim karakteristigi



$V(A) = 0 \qquad V(Y) = V_{DD}$

$V(A) > V_{DD} \qquad V(Y) = 0$

V_{IL} artarsa V_{OH} azalır

Unity Gain Points:

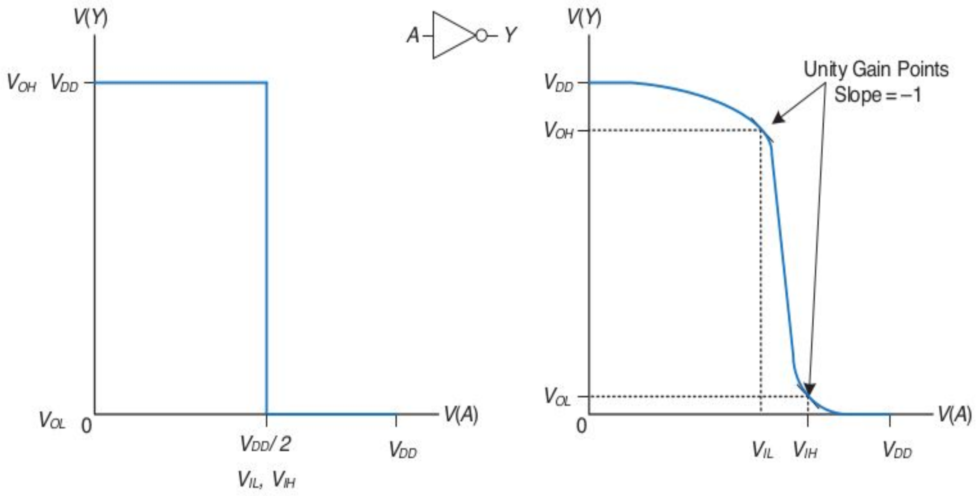
$dV(Y) / dV(A) = -1$

Lojik seviyeleri (0 yada 1) UGP noktaları olarak belirlemek sistemin gürültü toleransını en üst seviyeye çıkaracaktır.

Static displin

Dört büyük Lojik aile (70 ~ 90):

- Transistör-Transistör Logic (TTL)
- Complementary Metal-Oxide-Semiconductor Logic (CMOS)
- Low Voltage TTL Logic (LVTTL)
- Low Voltage CMOS Logic (LVCMOS)



Static displin

Logic Family	V_{DD}	V_{IL}	V_{IH}	V_{OL}	V_{OH}
TTL	5 (4.75–5.25)	0.8	2.0	0.4	2.4
CMOS	5 (4.5–6)	1.35	3.15	0.33	3.84
LVTTL	3.3 (3–3.6)	0.8	2.0	0.4	2.4
LVCMOS	3.3 (3–3.6)	0.9	1.8	0.36	2.7

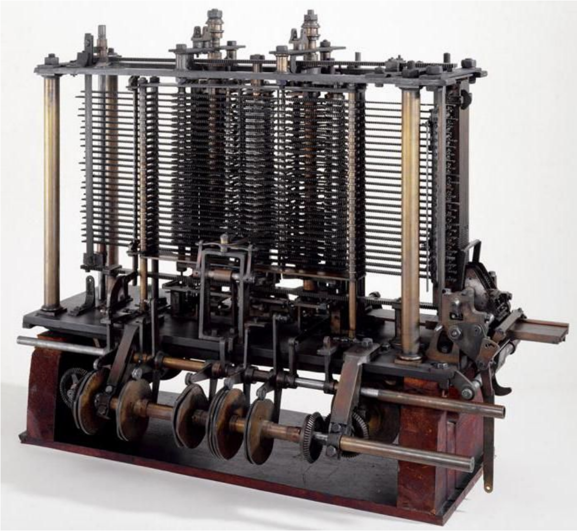
Static displin

		Receiver			
		TTL	CMOS	LVTTL	LVCMOS
Driver	TTL	OK	NO: $V_{OH} < V_{IH}$	MAYBE[a]	MAYBE[a]
	CMOS	OK	OK	MAYBE[a]	MAYBE[a]
	LVTTL	OK	NO: $V_{OH} < V_{IH}$	OK	OK
	LVCMOS	OK	NO: $V_{OH} < V_{IH}$	OK	OK

[a] As long as a 5 V HIGH level does not damage the receiver input

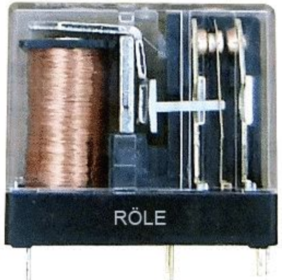
CMOS Transistorler

Babbage Analytical Engine



vakum tüp

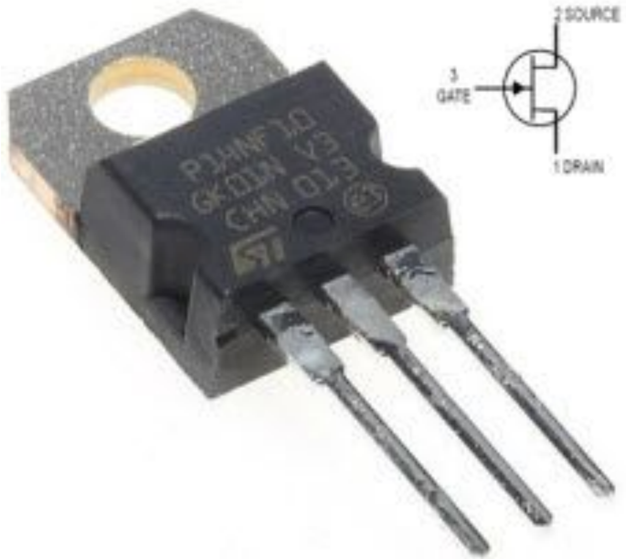
röle

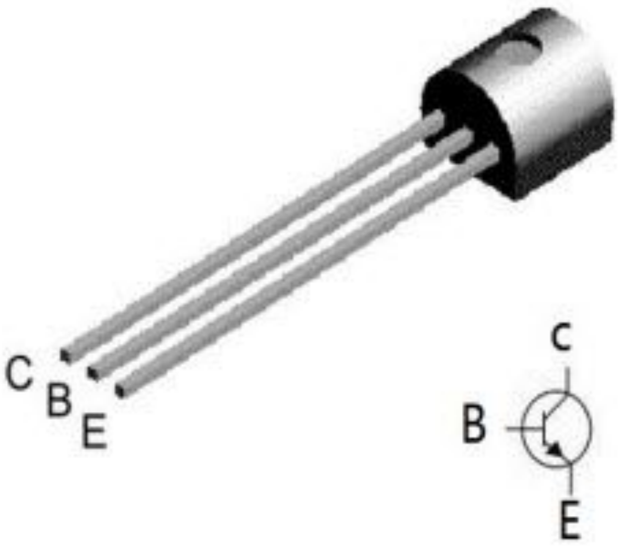


CMOS Transistorler

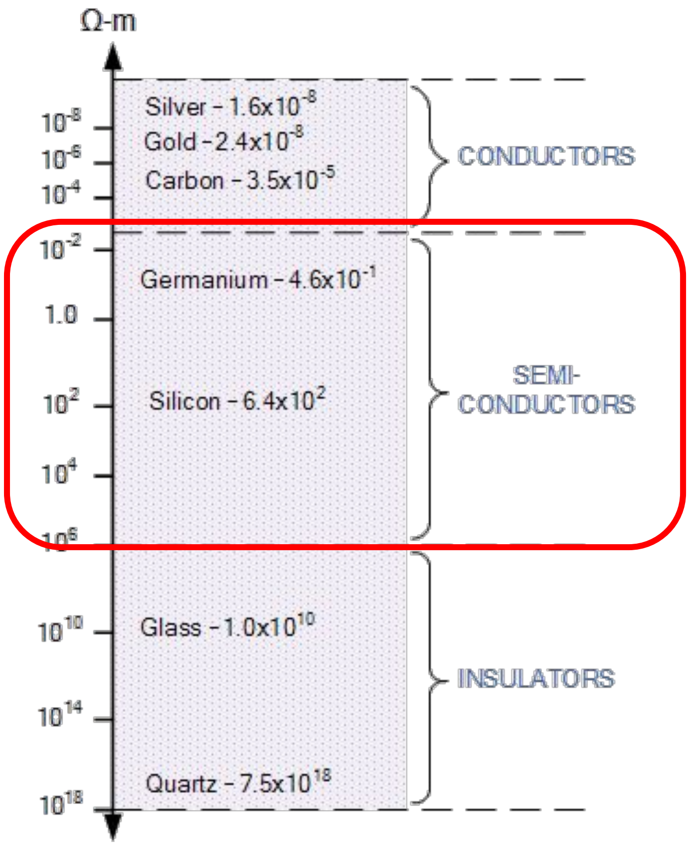
MOSFET
(metal-oxide-semiconductor field effect transistor)

BJT
(bipolar junction transistor)

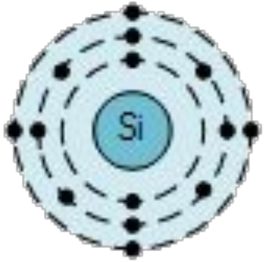




Yarıiletgenler

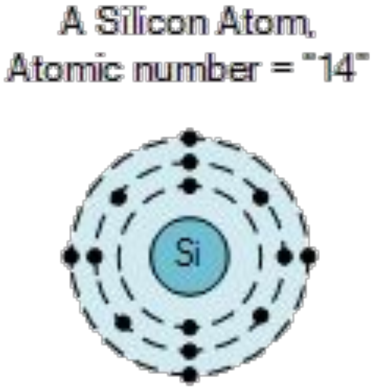


A Silicon Atom,
Atomic number = "14"

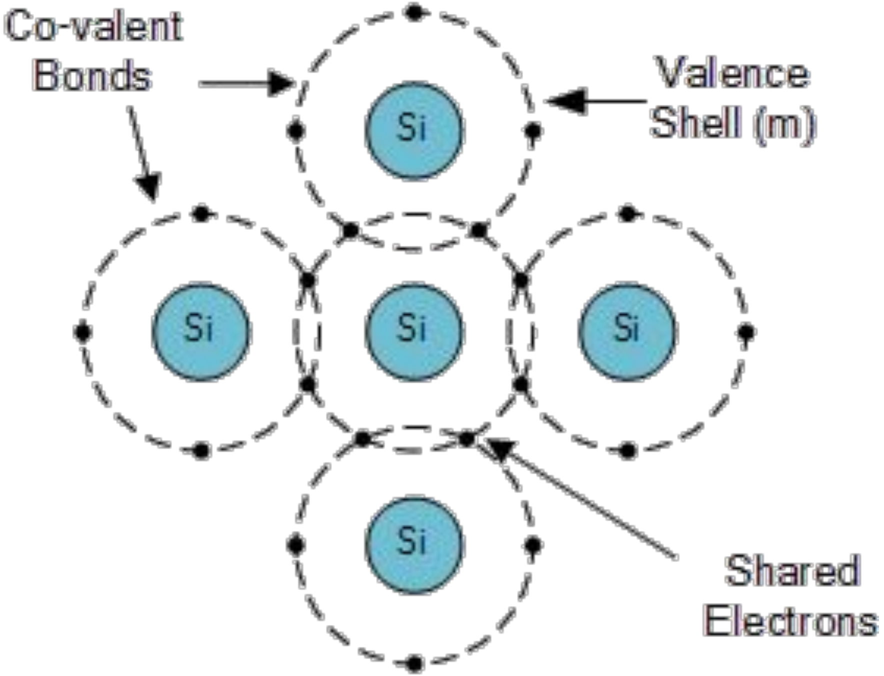


Silicon atom showing 4 electrons in its outer valence shell (m)

Yarıiletgenler



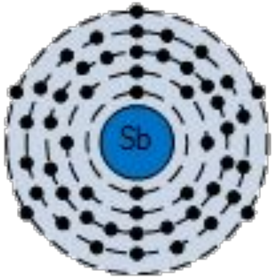
Silicon atom showing 4 electrons in its outer valence shell (m)



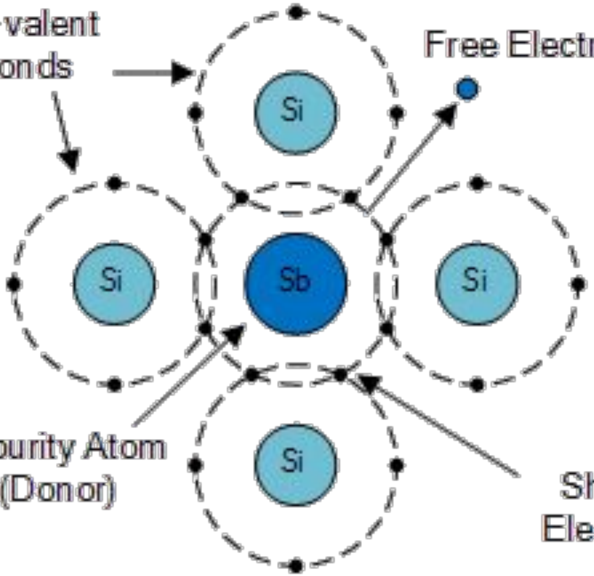
Silicon Crystal Lattice

Yarıiletgenler

An Antimony Atom,
Atomic number = "51"

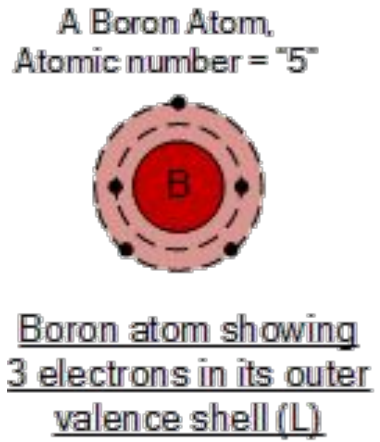


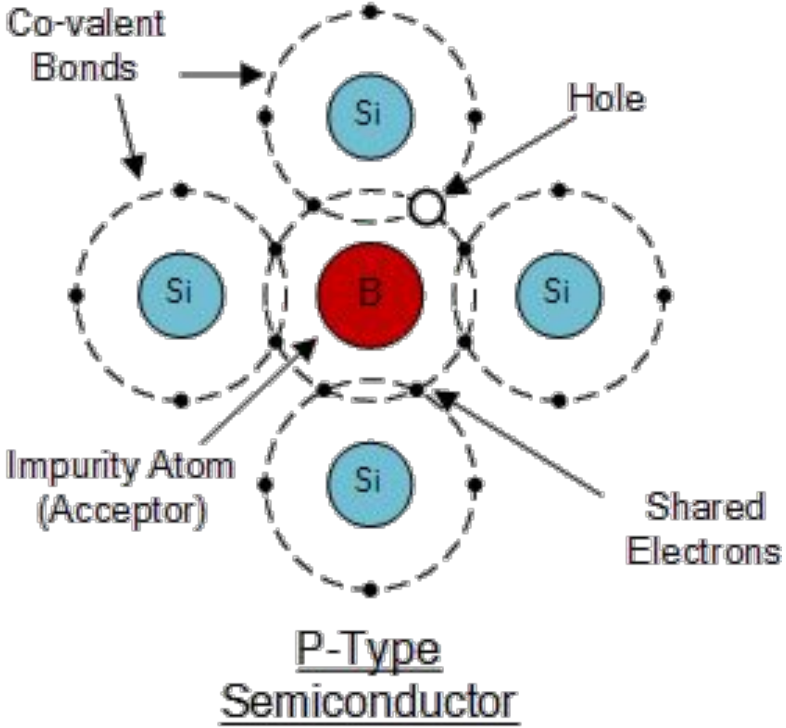
Antimony atom showing
5 electrons in its outer
valence shell (o)



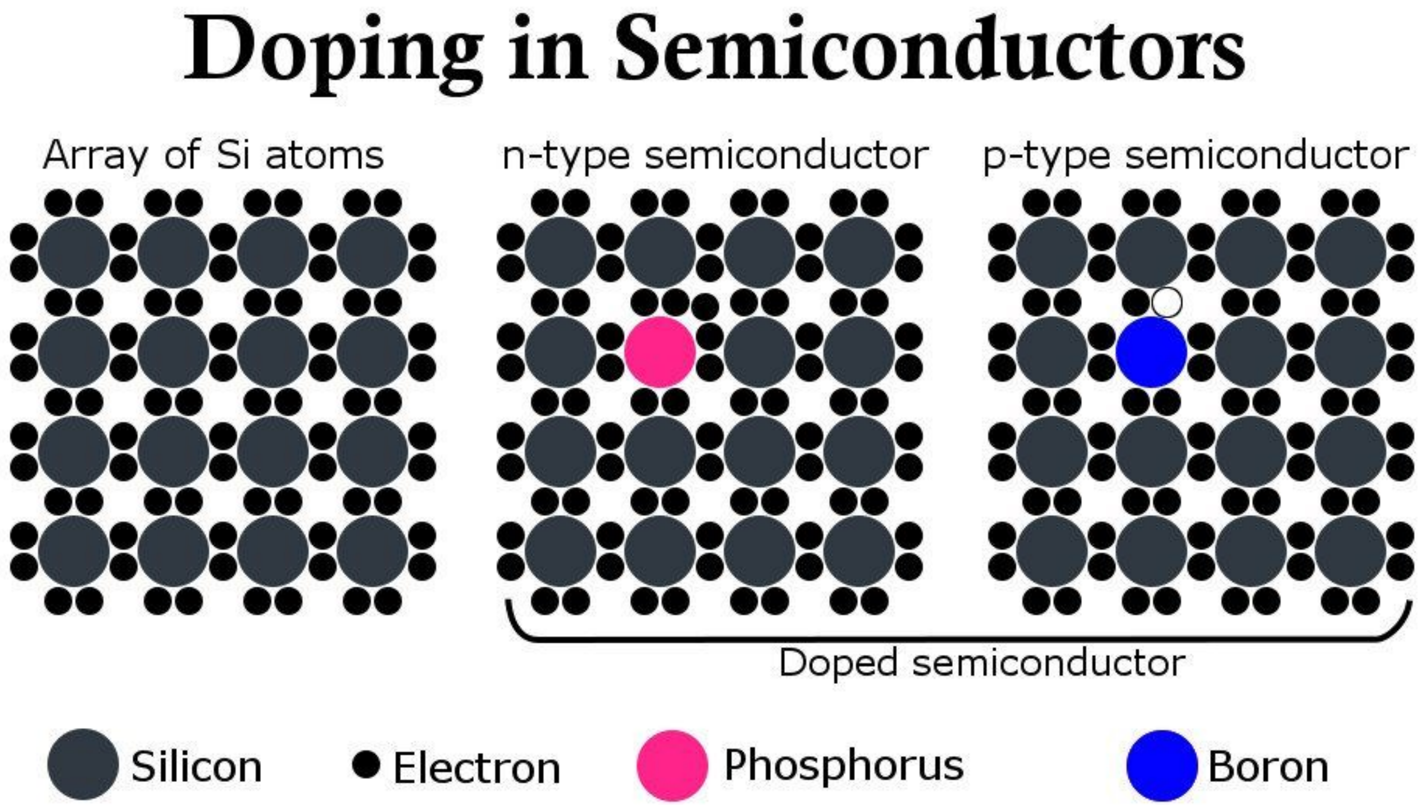
N-Type
Semiconductor

Yarıiletgenler

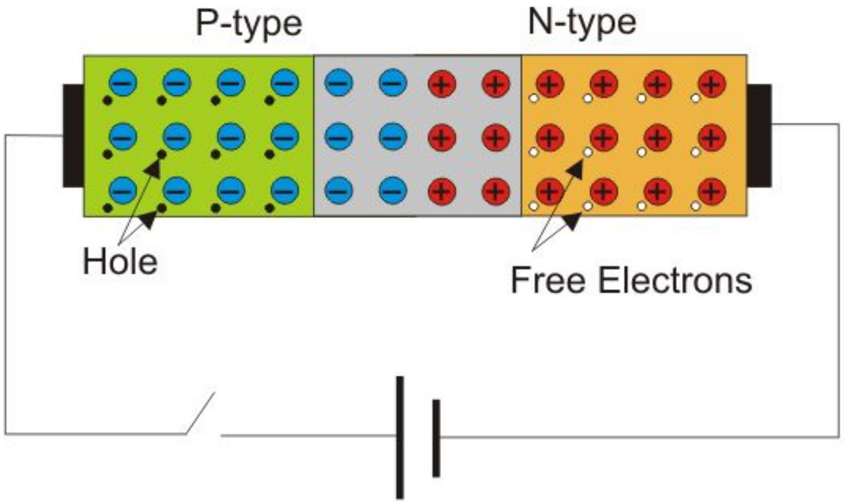


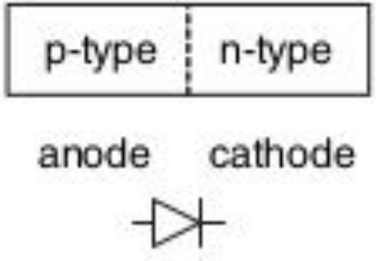


Yarıiletgenler

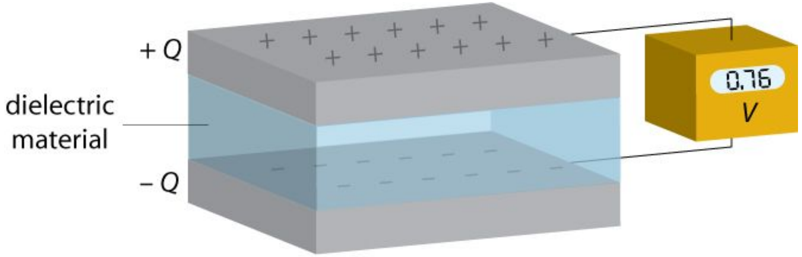


Diyod

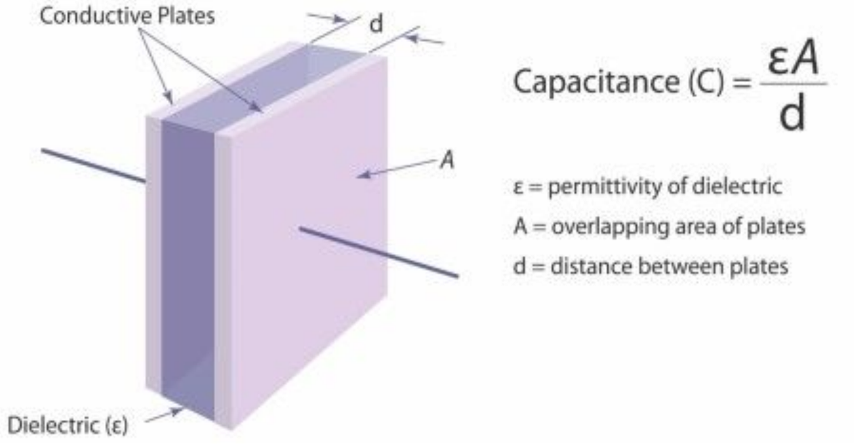




Kondansatör

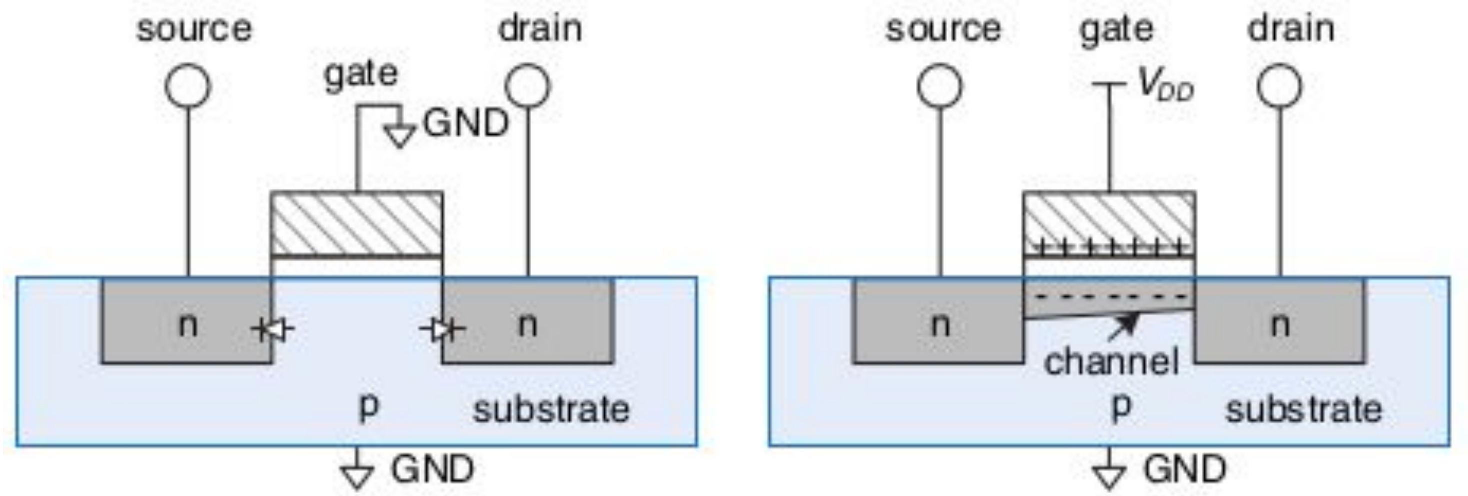


$$\boxed{Q = CV}$$



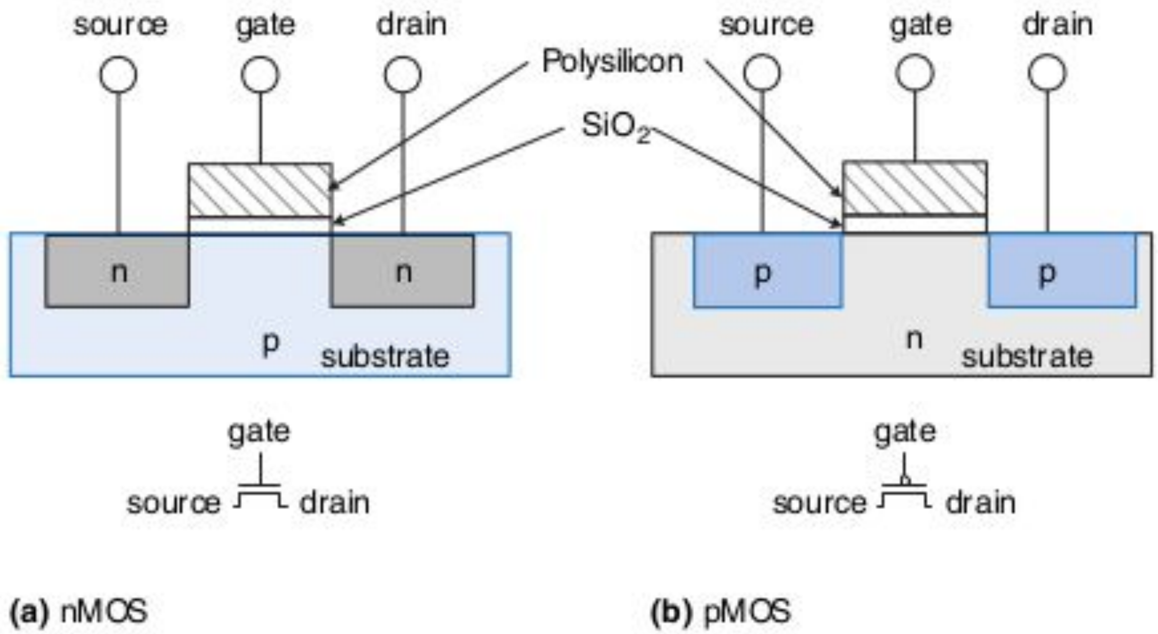
https://www.youtube

MOSFET (nMOS & pMOS)



https://www.youtube.com/watch?v=stM8dgcY1CA

MOSFET (nMOS & pMOS)



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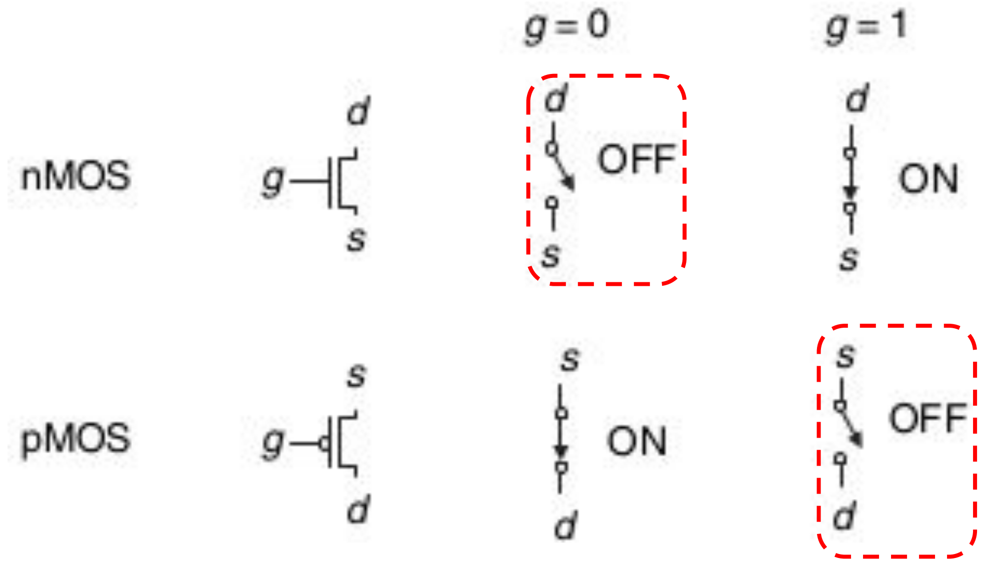
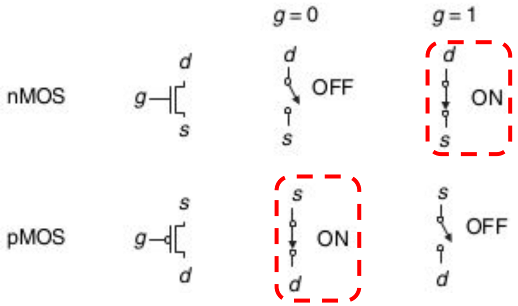
MOSFET (nMOS & pMOS)



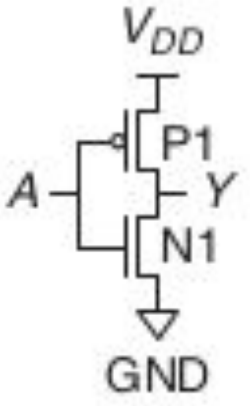
CMOS(Complementary MOS) Not Kapısı

N1 ⟶ NMOS

P1 ⟶ PMOS



NOT



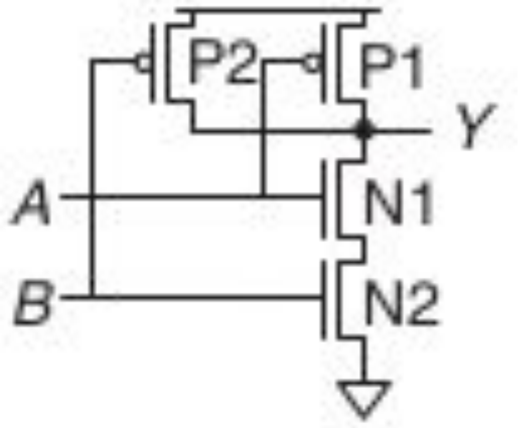
A=0 ⟶ NMOS = OFF & PMOS= ON

Y = VDD (logic 1)

A=1 ⟶ NMOS = ON & PMOS= OFF

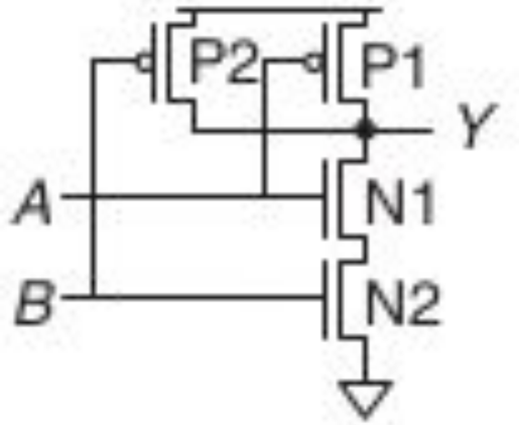
Y = GND (logic 0)

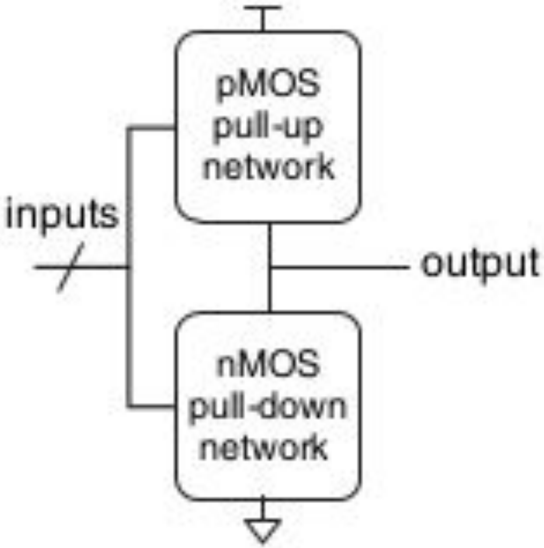
Two-input NAND gate



A	*B*	Pull-Down Network	Pull-Up Network	*Y*
0	0	OFF	ON	1
0	1	OFF	ON	1
1	0	OFF	ON	1
1	1	ON	OFF	0

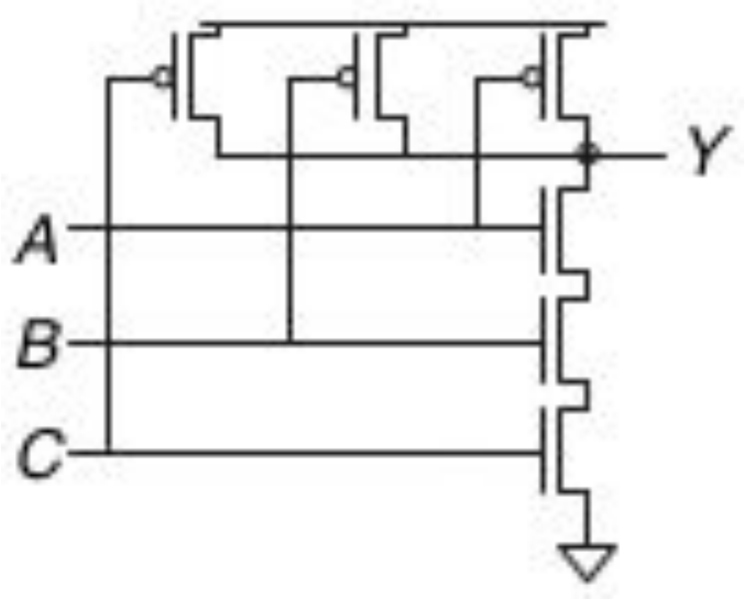
Two-input NAND gate



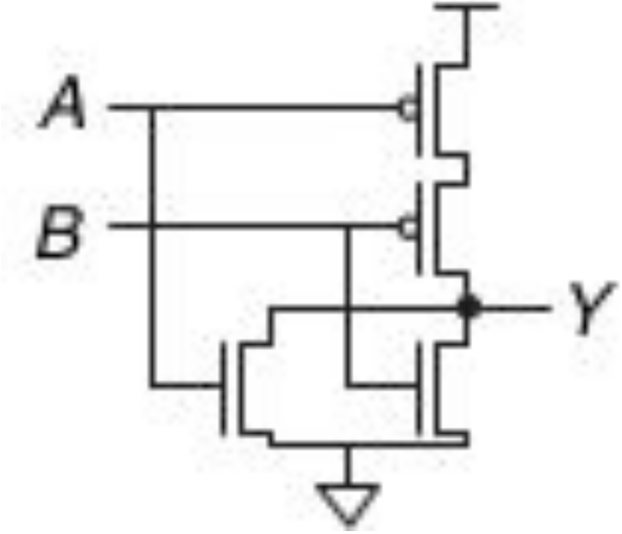


THREE-INPUT NAND SCHEMATIC

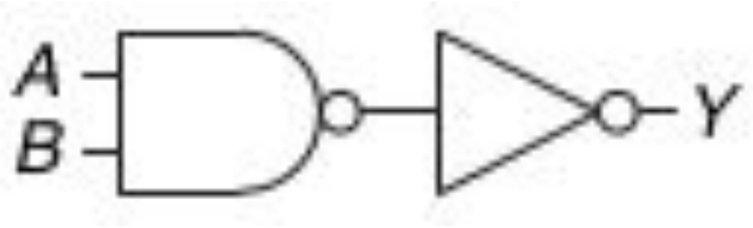
NAND



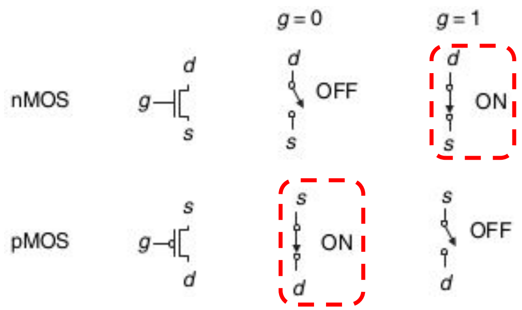
NOR

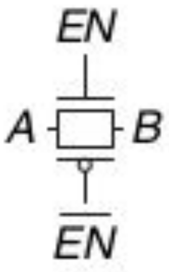


TWO-INPUT AND SCHEMATIC



Transmission Gates



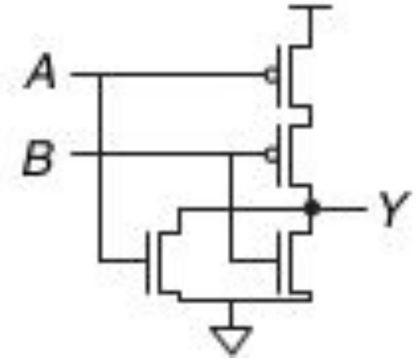


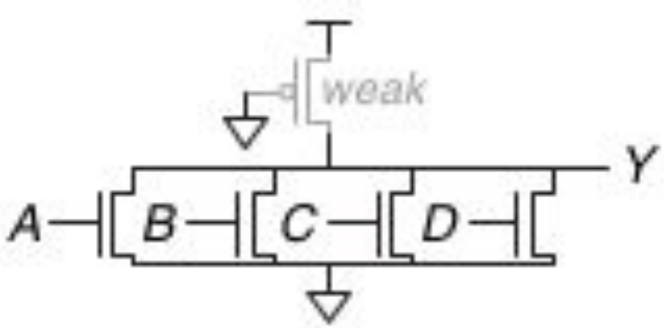
EN=0 & EN'=1 → nMOS,pMOs OFF

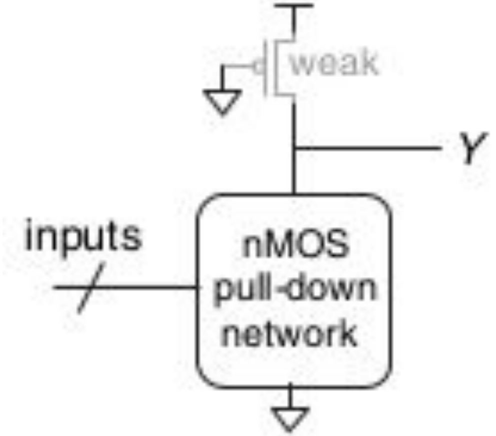
EN=1 & EN'=0 → nMOS,pMOs ON

Pseudo-nMOS Logic

NOR







Seri baglı devre elemanları paralel baglı devre elemanlarına göre daha yavastırlar.
pMOS transistörler nMOS transistörlere göre daha yavastır.

Güç Tüketimi(AKtif/Pasif Güç)

6 watt saatlik (W-hr) bataryaya sahip bir cep telefonu 1,2 V'da çalıssın;

Aktif kullanıldıgı durumda;

Frakansı: 300 MHz

Yonga içindeki ortalama kapasitans miktarı: 10 nF (10^{-8} Farads)

Anten gücü: 3 W

Batarya ömrü: ?

$$P_{\text{dynamic}} = \frac{1}{2} C V_{DD}^{2} f$$

Aktif kullanılMAdıgı durumda;

Dinamik güç: Yaklasık 0

Sakin Akım: 40 mA

Batarya ömrü: ?

$$P_{\text{static}} = I_{DD} V_{DD}$$

Güç Tüketimi

6 watt saatlik (W-hr) bataryaya sahip bir cep telefonu 1,2 V'da çalıssın;

Aktif kullanılMAdıgı durumda;

P_{static} = (0.040 A)(1.2 V) = 48 mW

Bateri ömrü = 6 (Whr)/(0.048 W) = 125 saat (Yaklasık 5 gün)

Aktif kullanıldıgı durumda;

$P_{dynamic}$ = (0.5)(10^{-8} F)($(1.2\ V)^2$ (3×10^8 Hz) = 2.16 W

Toplam güç: 2.16 W + 0.048 W +3 W = 5.2 W

Bateri ömrü = 6 Whr/5.2 W = 1.15 saat

$$P_{\text{dynamic}} = \frac{1}{2} C V_{DD}{}^2 f$$

$$P_{\text{static}} = I_{DD} V_{DD}$$

Sorular