Analog and Digital Electronics

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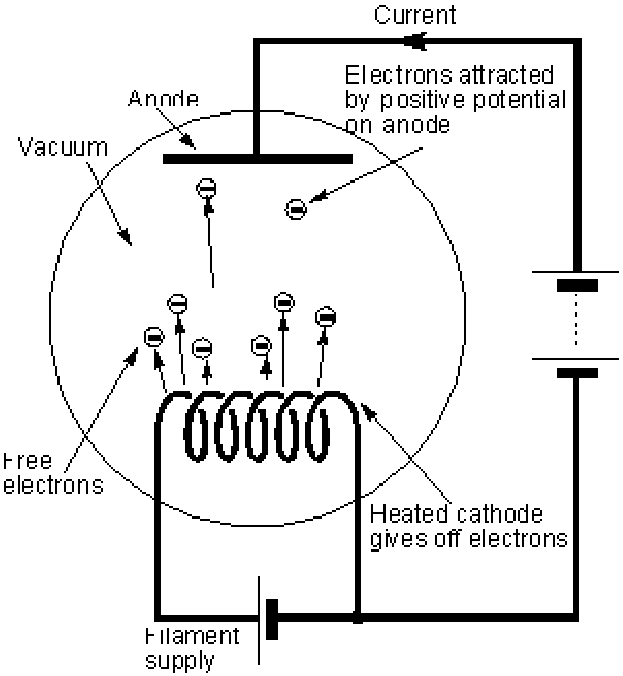
What is Analog and Digital?

History of Electronics?

1904

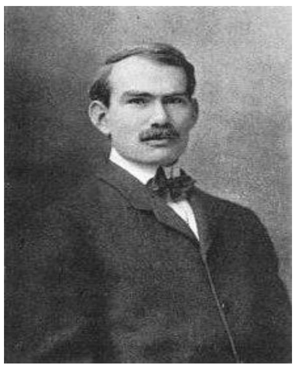
John Fleming → Vacuum tube

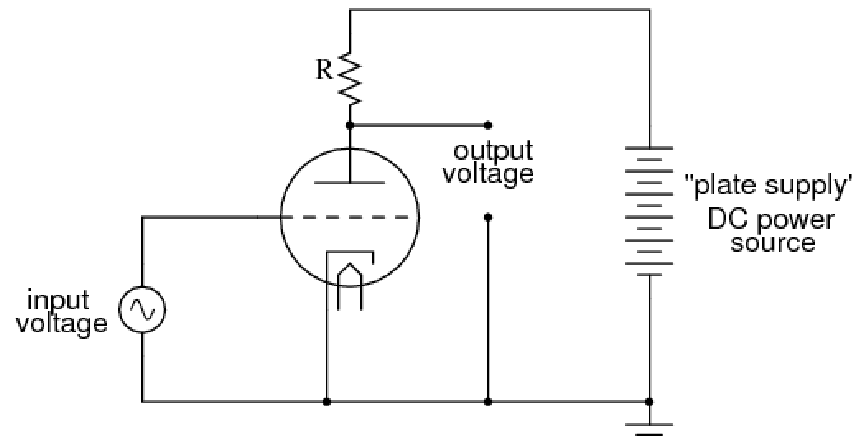


History of Electronics?

<u>**1907**</u>

Lee De Forest → Triode

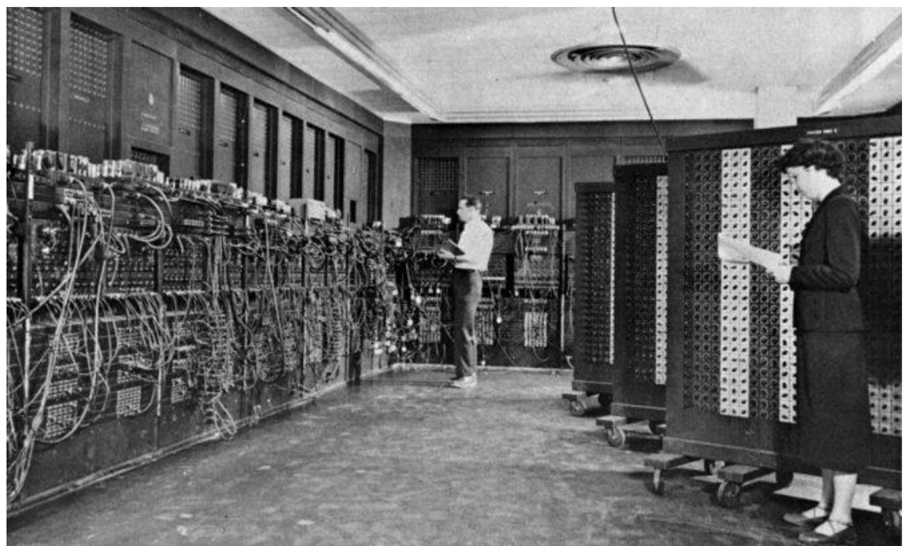




History of Electronics?

1946

Eniac Computer → Using 17468 Vacuum Tubes

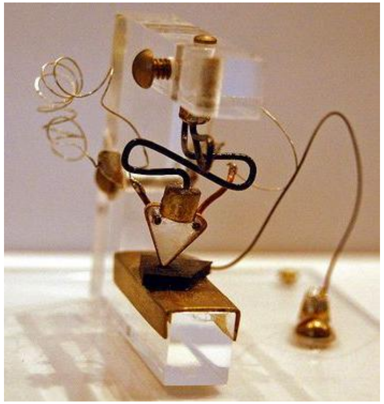


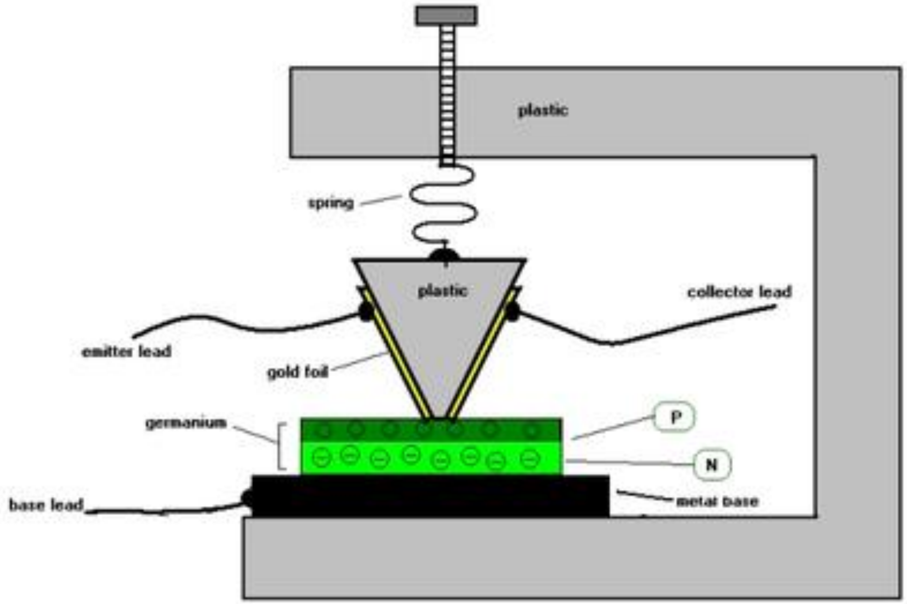
History of Electronics?

1947

Bell Lab → Transistor

Bardeen, Brattain, Shockley

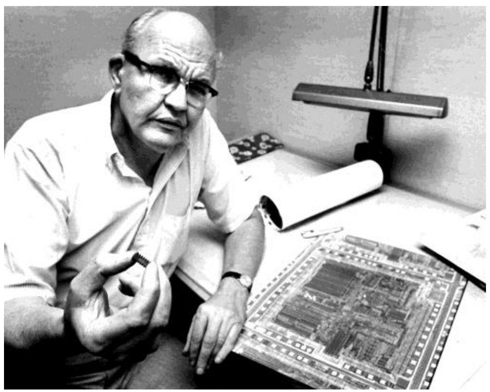




History of Electronics?

<u>**1958**</u>

Invented Integrated Circuit (IC) (Microchip)



Jack Kilby (Texas Inst.)

Robert Noyce (Fairchild Semi cond. & Intel)

History of Electronics?

1961 → First commercial IC from Fairchild Semiconductor

1968 → First commercial IC Op-amp

1967 → One Transistor DRAM cell invented by Dennard at IBM

1971 → 4004 Intel microprocessor introduced by Intel

1972 → First commercial 1-kilobit memory by Intel

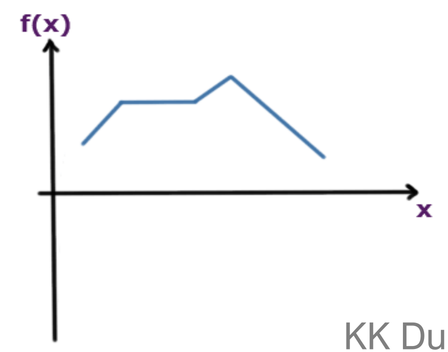
1974 → 8080 microprocessor introduced by Intel

1984 → Megabit memory chip introduced by IBM

What is signal?

Signal is a function → represents the variation of a physical quantity w.r.t. any parameter.

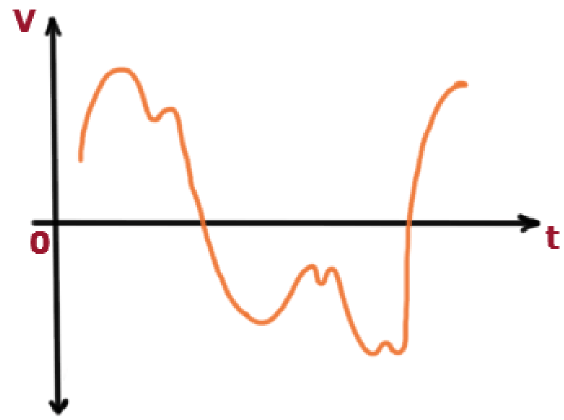
- In the above figure, f(x) is the signal or function and x is the independent variable.
- In electrical and electronics,
  - usually signal is a variation of electrical quantity (generally I or V) with time.
- If current or voltage remains same with change in time then →dc value (not signal)
- We use transducers to convert non-electrical signals to electrical signals. Reverse transducers are used to convert electrical signals back to non-electrical signals.



What is signal?

Analog signal:

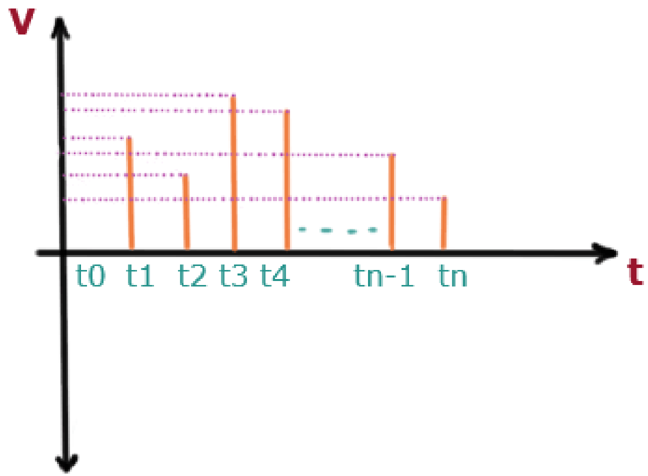
Analog signal is signal → which can take any value within the given limit



What is signal?

Discrete Time Signal:

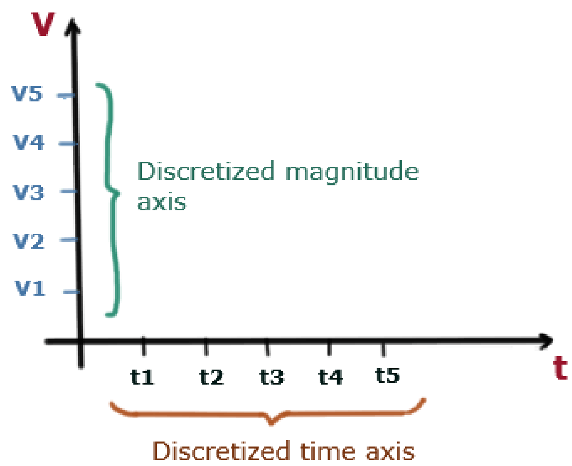
which is defined for discrete intervals of time is called discrete time signal



- In case of discrete time signals, the x-axis (time axis) is discretised in equal intervals.
- Discretisation of time axis means division of time axis in equal intervals
- All real life signals are analog in nature
- Discrete time signal is the subset of analog signal

What is Digital Signal?

Digital Signal → Discretised both time and magnitude



- Divide the magnitude axis into fixed number of levels
- The signal can take value equal to these levels only
- If the value is not equal to allowed levels, just take the lower level as the value for that time
- On increasing number of levels accuracy increases and thus error decreases

Need of Digital Signal

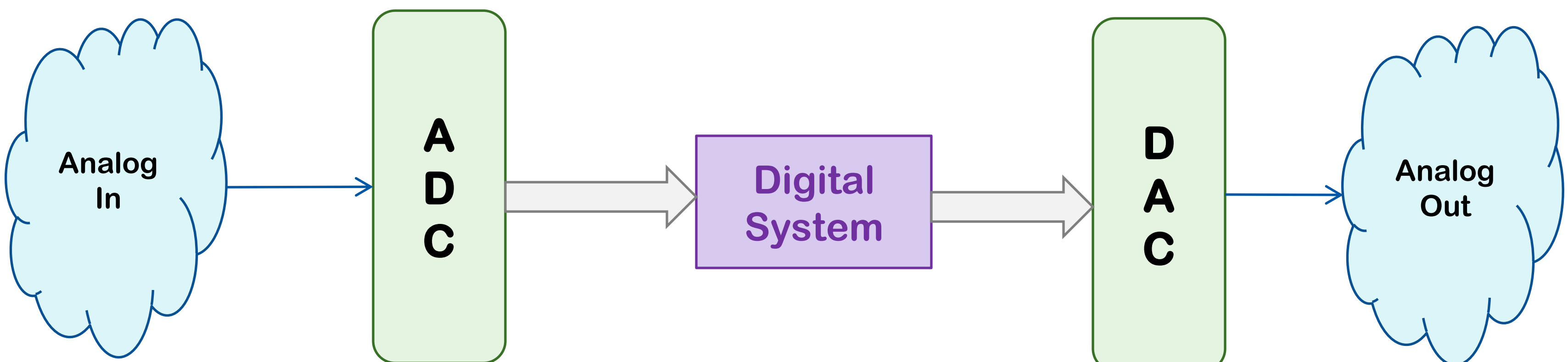
- All real life signals are analog in nature
- it seems use of analog is much better as compared to digital signal.
- But digital signals have various advantages over the analog signal
  - Noise immunity (used in communication process)
  - Digital Signals carry more information per unit time as compared to analog signals
  - Quality of digital signal is better over long distance transmission
  - Use of bandwidth is less in case of transmission using digital signals
  - We can encrypt digital signals
  - Noise removal is easy in digital signals

Introduction of Digital Electronics

We use analog to digital converter to convert analog signal to digital signal

Examples of digital system → Computer, calculator, digital watch, measuring instruments

We use digital to analog converter to convert digital signal back to analog signal

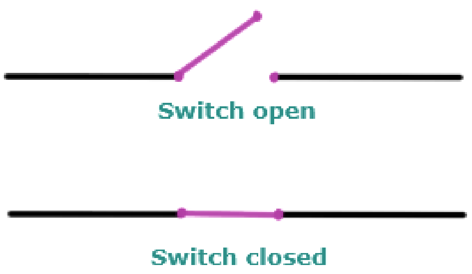


Digital Electronics

Switch and Bits Intuitions

On increasing number of levels accuracy increases

- We can represent two levels by using one switch
- If switch is open it is OFF(0) and if switch is closed it is ON(1)
- 0V is represented by ''0''. 5V is represented by ''1''.
- Where 0 and 1 are symbols

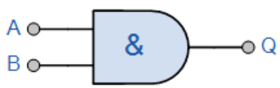


If n is number of levels and m is number of switches, then

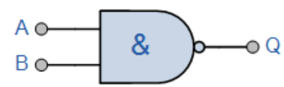
$$n=2^m$$

Logic Gates

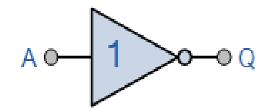
Symbol	Truth Table		
AND	B	A	Q
	0	0	0
	0	1	0
	1	0	0
	1	1	1
Boolean Expression **Q = A.B**	Read as A **AND** B gives Q		



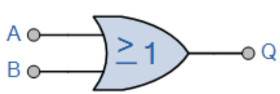
Symbol	Truth Table		
NAND	B	A	Q
	0	0	1
	0	1	1
	1	0	1
	1	1	0
Boolean Expression $Q = \overline{A . B}$	Read as A **AND** B gives **NOT** Q		



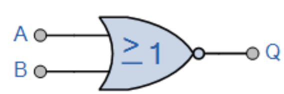
Symbol	Truth Table	
NOT	A	Q
	0	1
	1	0
Boolean Expression Q = not A or $\overline{A}$	Read as inverse of A gives Q	



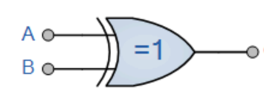
Symbol	Truth Table		
OR	B	A	Q
	0	0	0
	0	1	1
	1	0	1
	1	1	1
Boolean Expression Q = A + B	Read as A **OR** B gives Q		



Symbol	Truth Table		
NOR	B	A	Q
	0	0	1
	0	1	0
	1	0	0
	1	1	0
Boolean Expression $Q = \overline{A + B}$	Read as A **OR** B gives **NOT** Q		



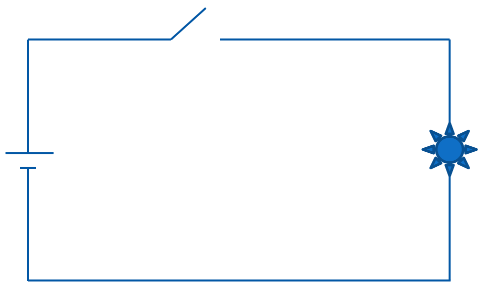
Symbol	Truth Table		
Ex-OR	B	A	Q
	0	0	0
	0	1	1
	1	0	1
	1	1	0
Boolean Expression $Q = A \oplus B$	Read as A **OR** B but not **BOTH** gives Q (odd)		



KK Dudani

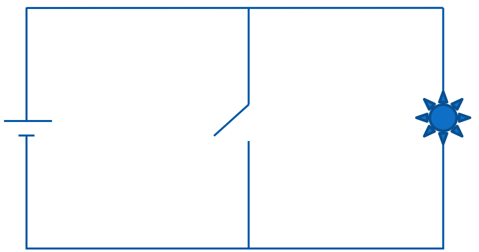
Switching Circuit

Series circuit

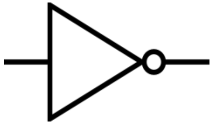


A	Y
0	0
1	1

Parallel circuit



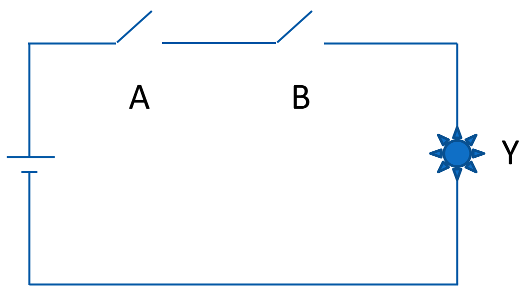
A	Y
0	1
1	0



NOT Gate

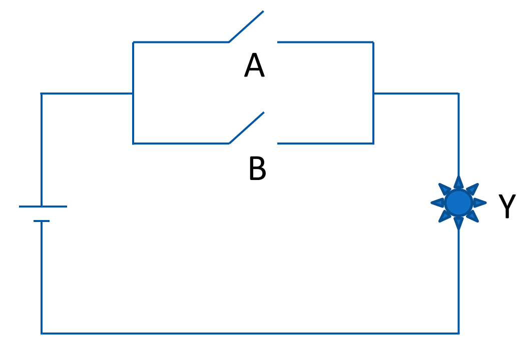
Switching Circuit

AND Gate



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

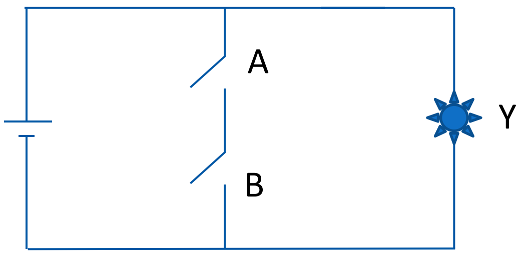
OR Gate



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

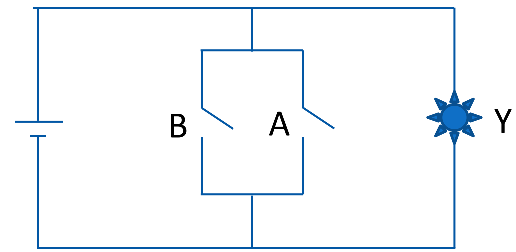
Switching Circuit

NAND Gate



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

NOR Gate

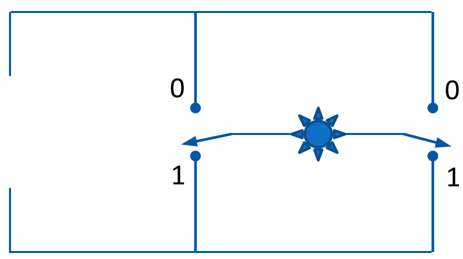


A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Switching Circuit

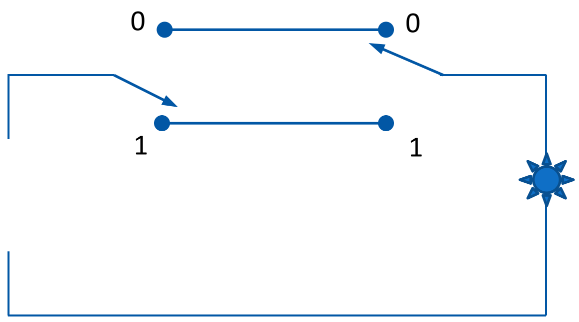
EX-OR Gate

Odd one detector



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

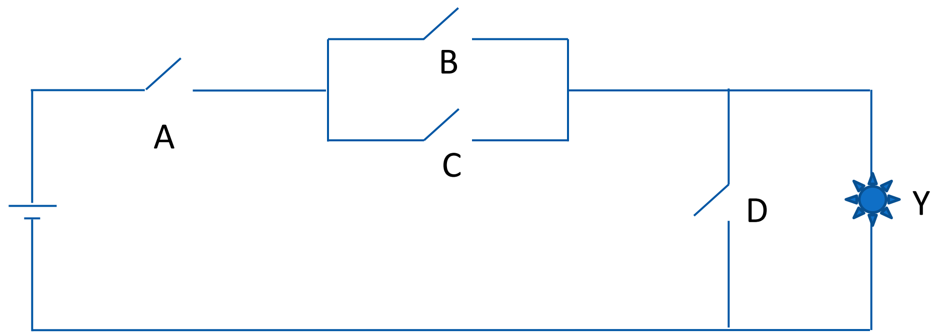
EX-NOR Gate



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

Switching Circuit

Determine Y



$$A.(B+C).D'$$

Number System

System	Base (r)	Number (r-1)
Binary	2	0, 1
Octal	8	0, 1, 2, 3, 4, 5, 6, 7
Decimal	10	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
Hexadecimal	16	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F