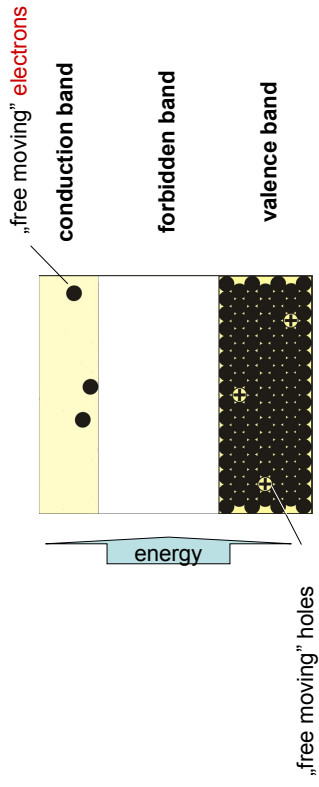


# Electronics basics

Szabolcs Osváth

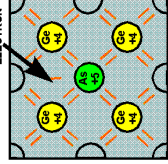
Semmelweis University  
szabolcs.osvath@eok.sote.hu

## Energy structure of semiconductors

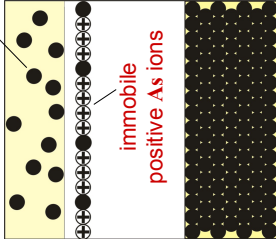


## Doped semiconductors

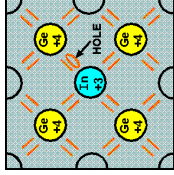
**N-type**



„free moving” electrons

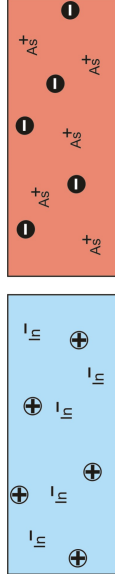


**P-type**



## P-N junction (without outer electric field)

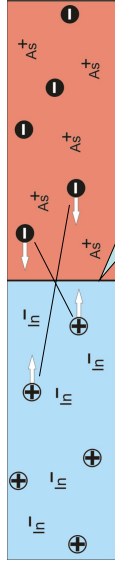
before connecting them



P-type

N-type

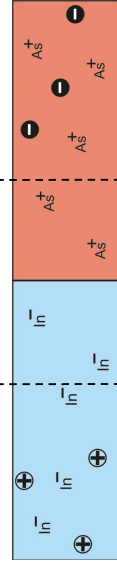
diffusion, recombination



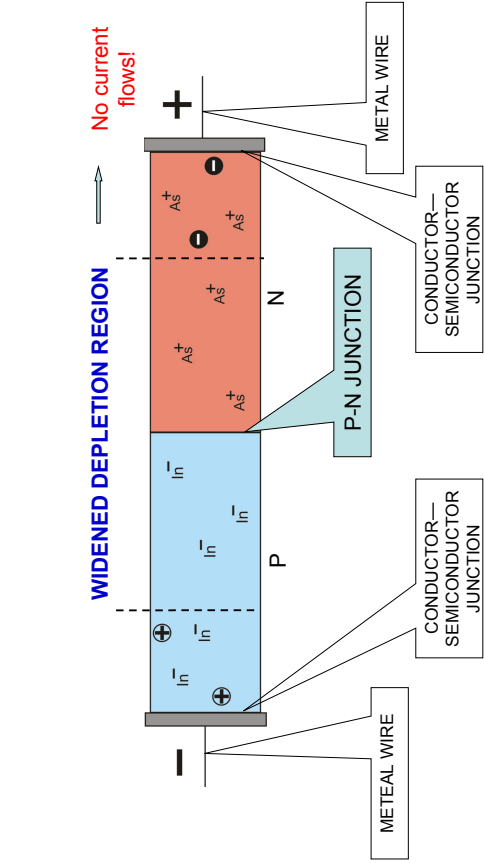
at the moment of connecting them

diffusion of electrons and holes  
**EQUILIBRIUM**  
opposite charge of In, As ions

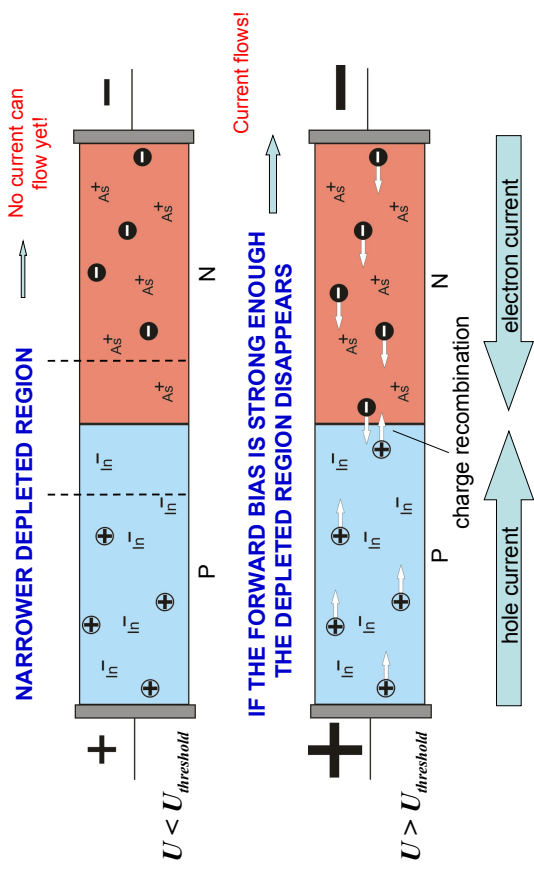
DEPLETION REGION



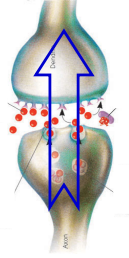
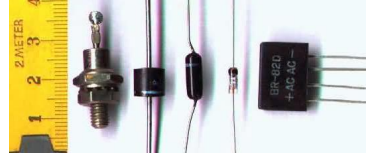
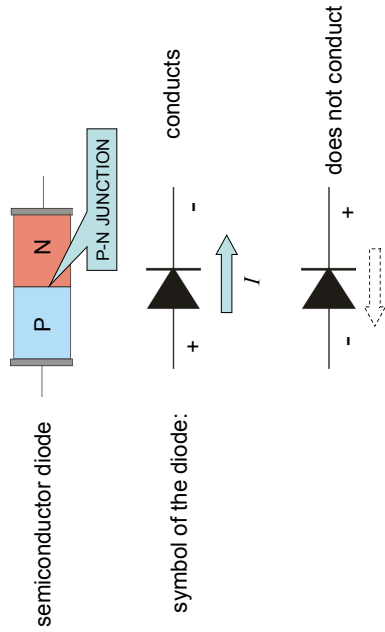
# P-N junction (reverse bias)



# P-N junction (forward bias)

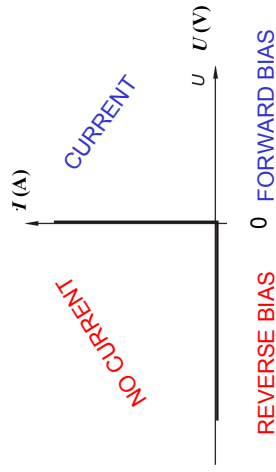


# P-N junction rectifying diodes

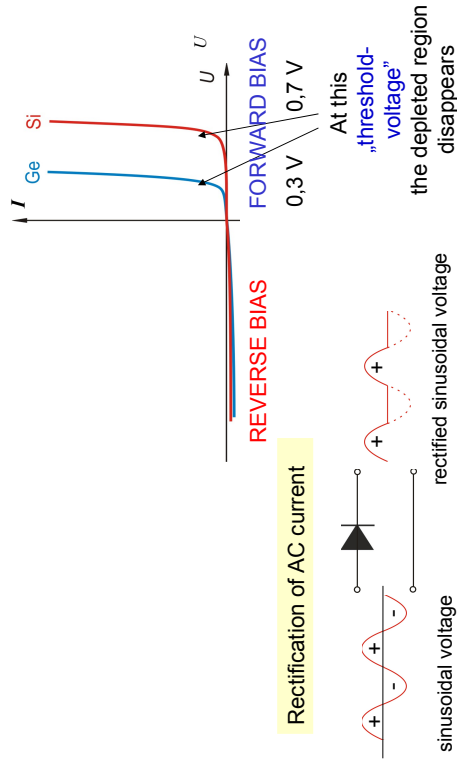


Biological analogy: SYNAPSIS

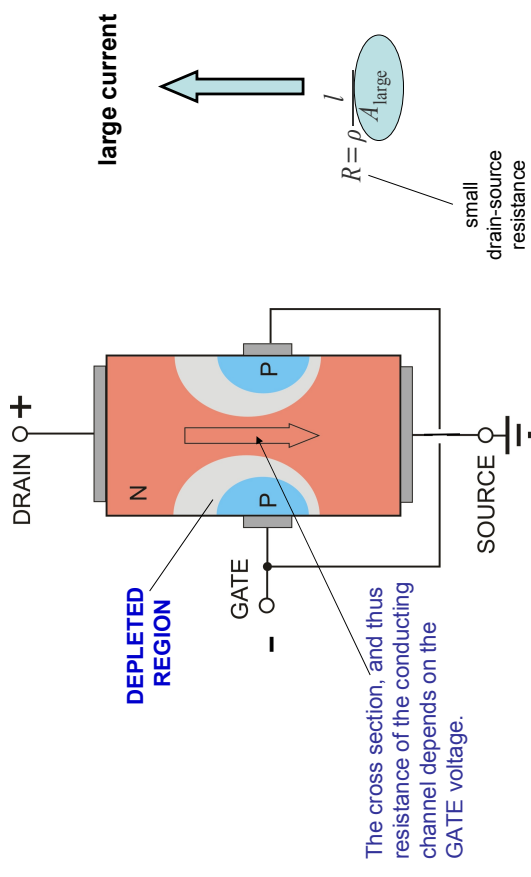
# Diode characteristics (IDEAL DIODE)



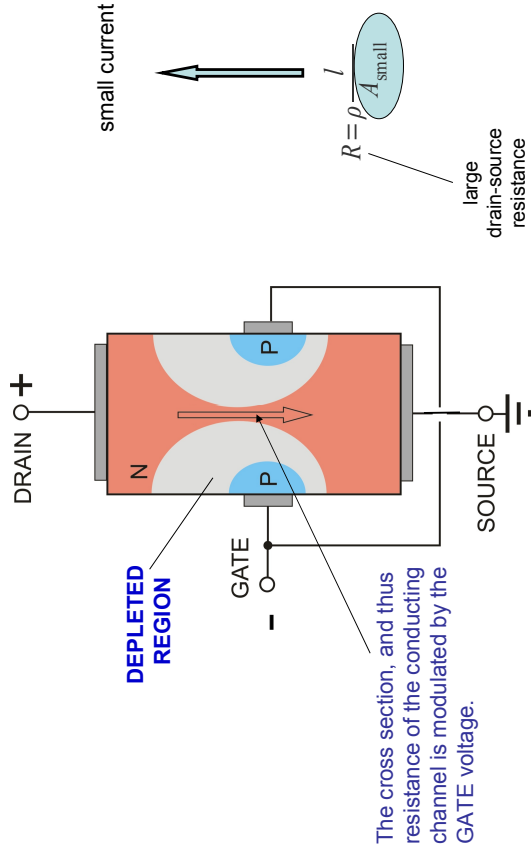
## Diode characteristics (REAL DIODE)



## Field effect transistor I. (FET)



## Filed effect transistor II. (FET)



## Field effect transistor III. (FET)

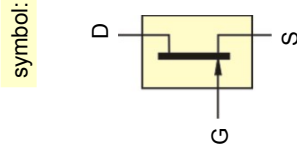
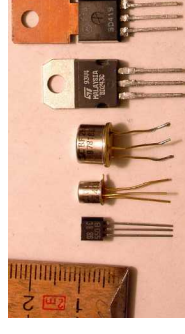
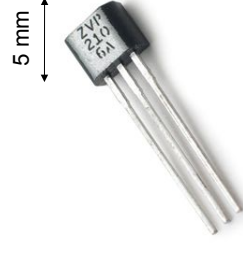
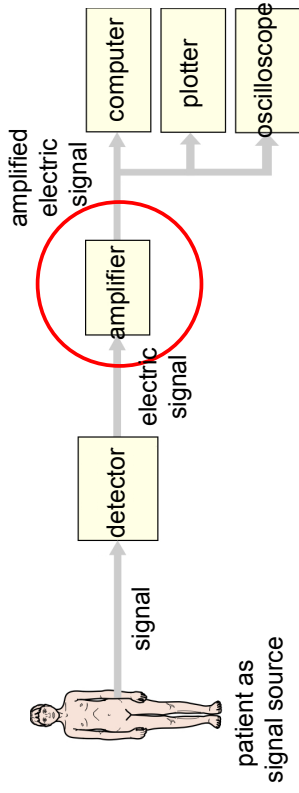


photo:

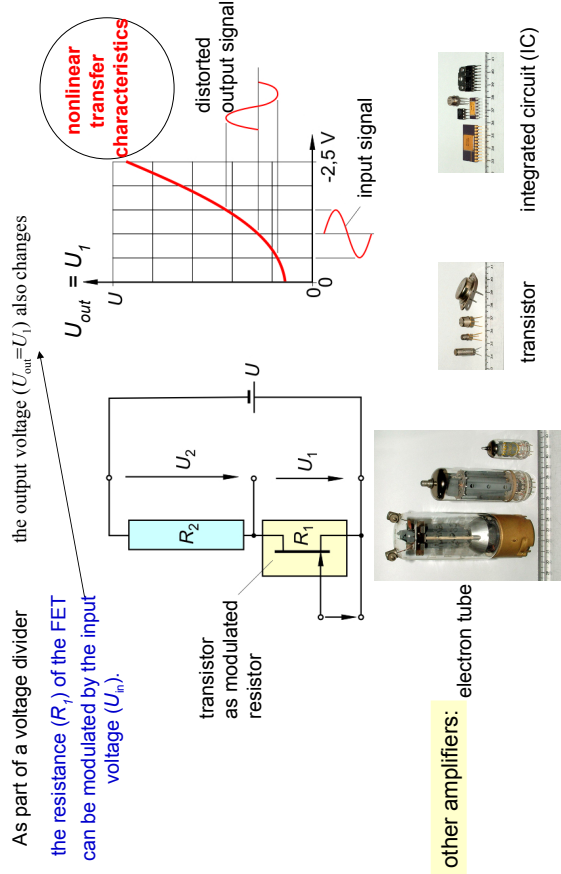
5 mm



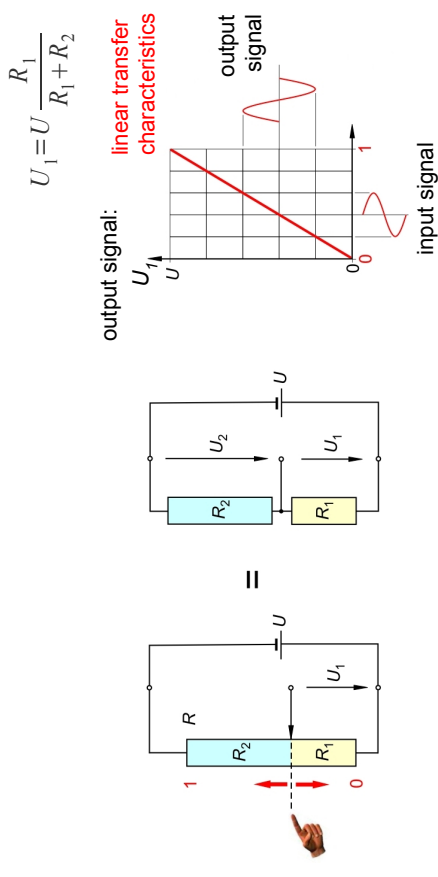
## Analog devices (Amplifier)



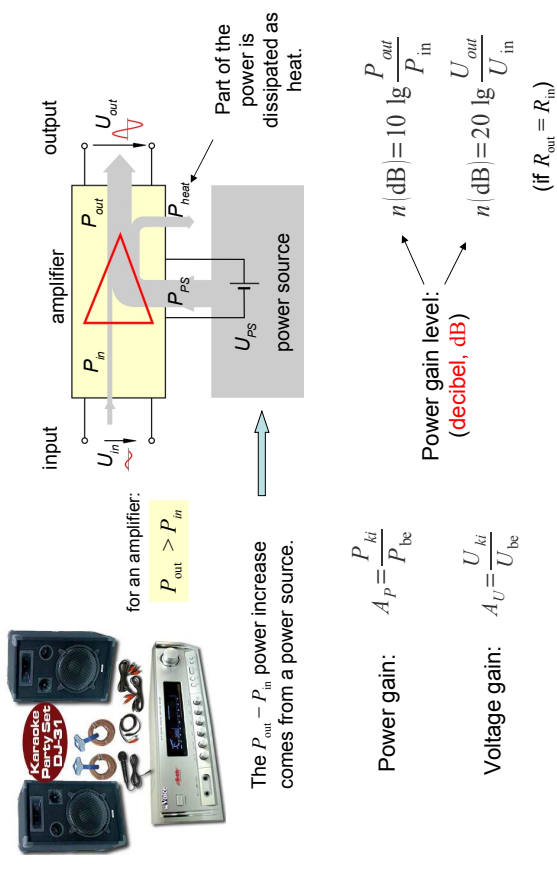
## Amplifying with transistor



## Voltage divider potentiometer as amplifier?

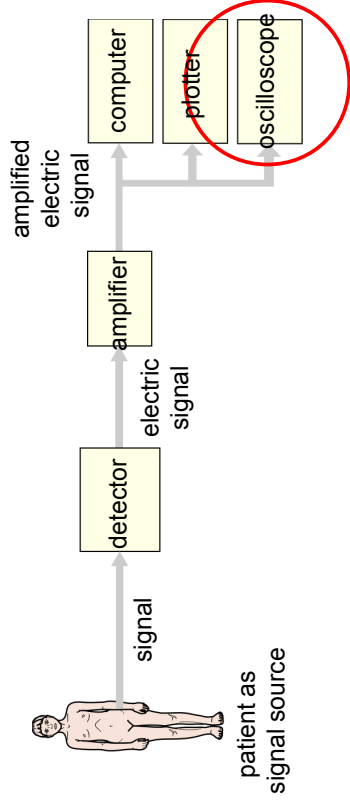


## Parameters of amplifiers



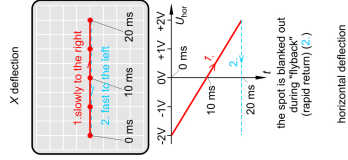


## Analog devices (Oscilloscope)



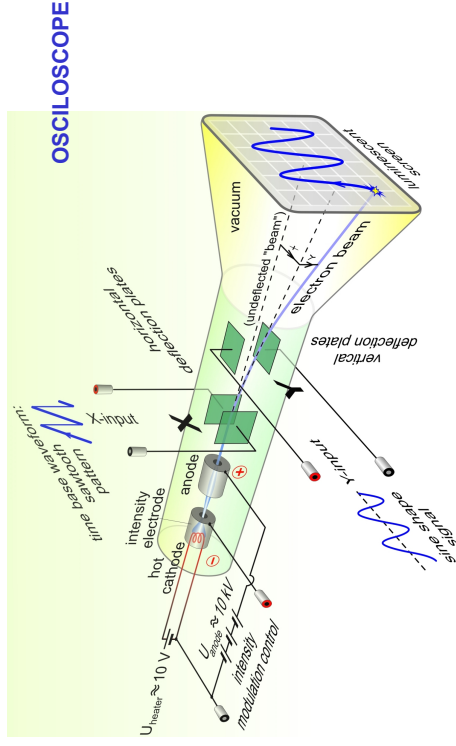
## Controlling the cathode ray tube I.

**X displacement** = generating TIME scale with uniformly increasing voltage



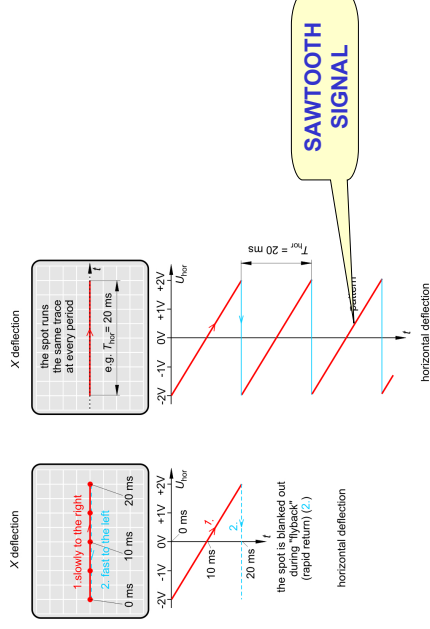
a)

## Cathode ray tube (CRT)



## Controlling the cathode ray tube II.

**repeated X displacement** = generating TIME scale with sawtooth voltage



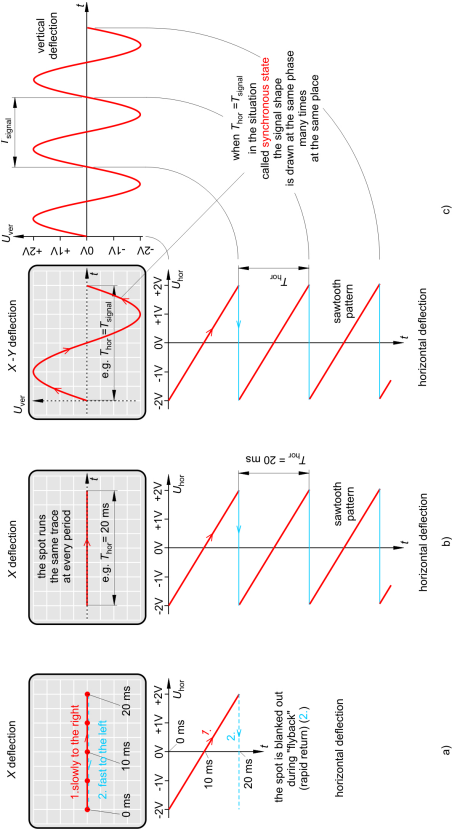
a)

b)

# Controlling the cathode ray tube III.

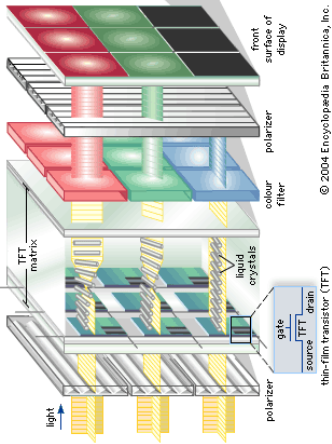
**X displacement = TIME scale generated by sawtooth signal**

**Y displacement = SIGNAL VOLTAGE**

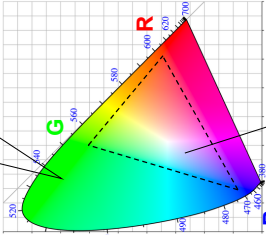


# Color LCD

color pixel (RGB)



sensitivity of the human eye

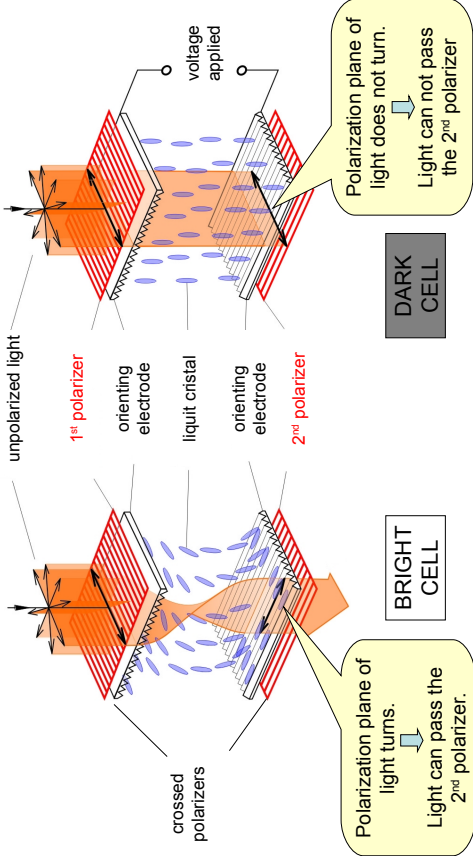


With the weighted addition of the **RGB** colors new colors may be generated.

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# LCD (Liquid Crystal Display)

PIXEL



# Pixels of a color LCD

