20. May 2018, IED - Rezelme

①

Industrial Electronic Devices

Overview:

- Diodes
- Bipolar transistor
- FET transistor
- Thyristor (THYRISTOR)
- PV Cells (PHOTO VOLTAIC CELLS)
- OP (operational amplifier)

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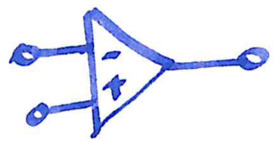
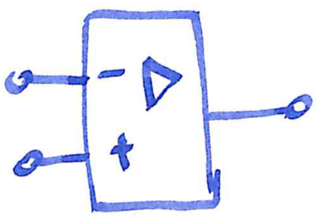
- Today OP

- flexible device
- general device
- simple to handle dev.
- dev. for people without big electrical background

⋮

Symbol:  {old}

or  {new}

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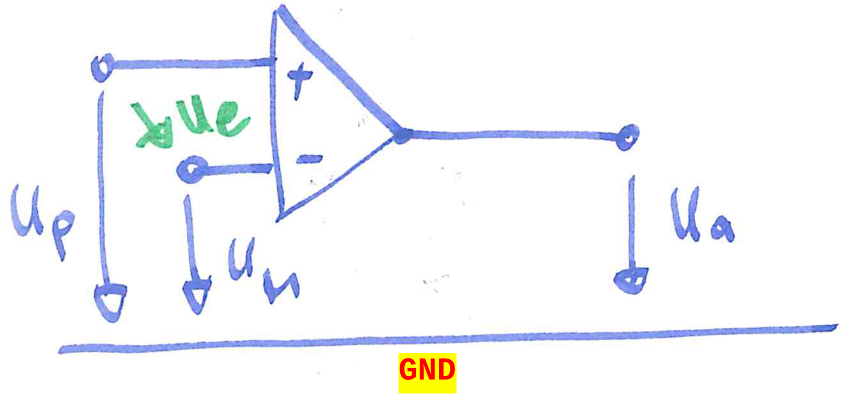


Basic equation of each OP:

$$U_a = v_0 \left(U_p - U_M\right) = v_0 \cdot U_e$$

Example: $U_p = 0.3V$; $U_M = 0.1V$

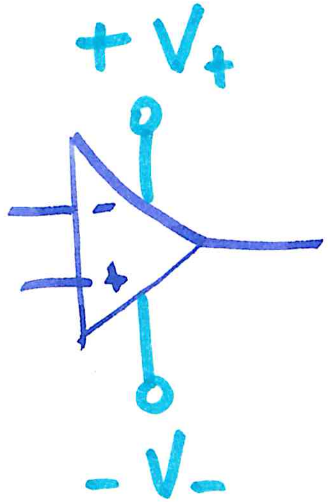
$v_0 = 10^4 \Rightarrow$ gain ($10^4 .. 10^6 ..$)

$U_a = 10^4 \cdot (0.3V - 0.1V)$

$= 10^4 \cdot 0.2V = 2000V$

→ Which electronic circuit has 2000V? ⇒ NO!

From where shall 2000V come?



V_+ can be 5V..10V..15V

V_- " " −5V..−10V..−15V

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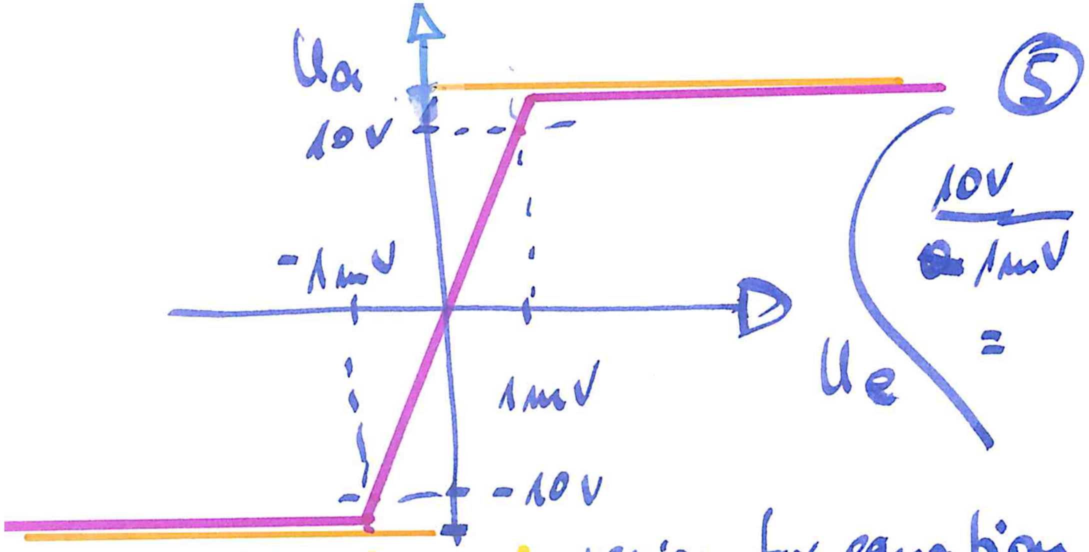

region for equation

$$\frac{10V}{1mV} = \frac{10\,000\,\mu V}{1\,\mu V} = 10^4$$

$V_+ = 12V$; $V_- = -12V$

 → characteristic diagram

> if the OP is used as an amplifier, it operates only in [yellow region].

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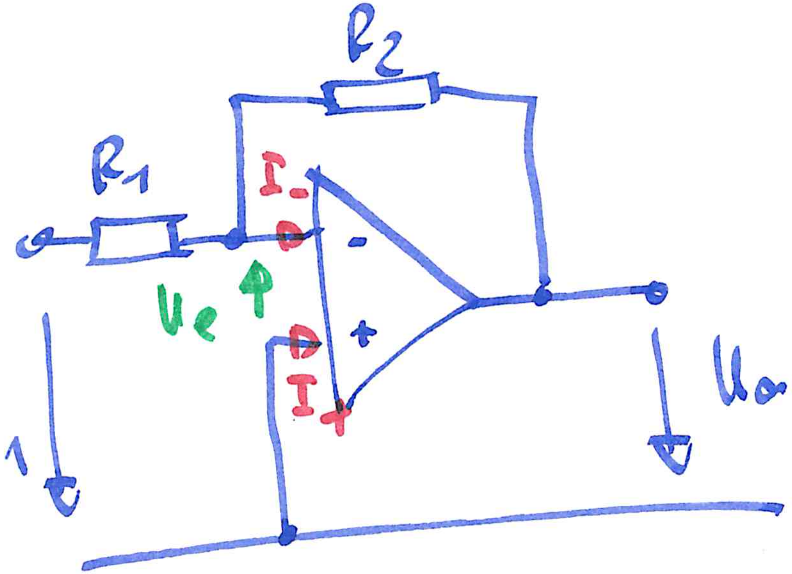
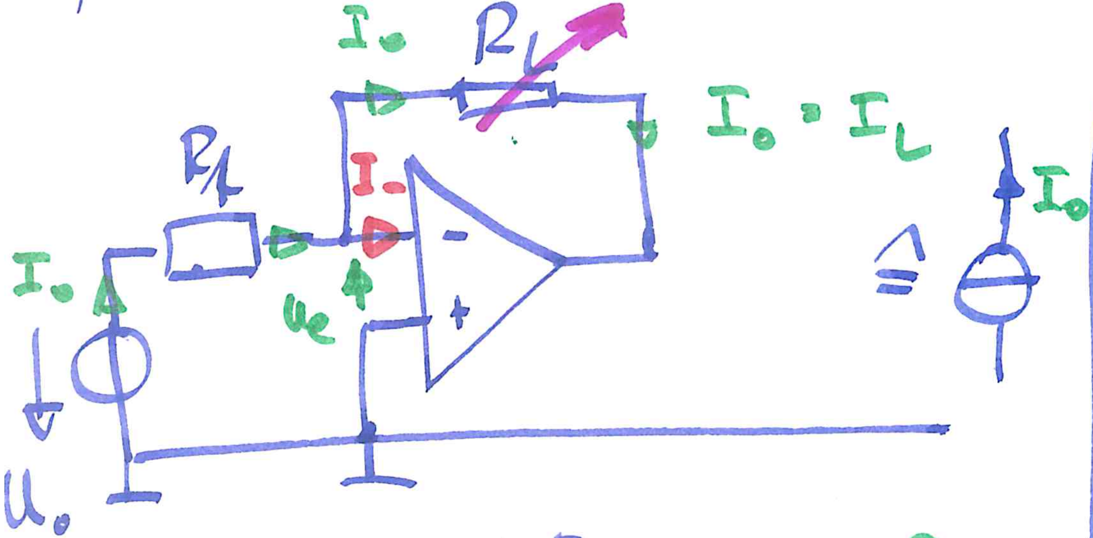
- What is in the OP? → see google: Inside OP or "Inside operational amp."
  {lot of transistors and...}
- How it operates?



Text-book from India: (7)

Applications with OP (ideal OP)

1.) Current source !



$I_- = I_- \approx 0V$! $U_e \approx 0$

$I_0 = \frac{U_0}{R} = I_L = const$

(U_0: const; R: const)

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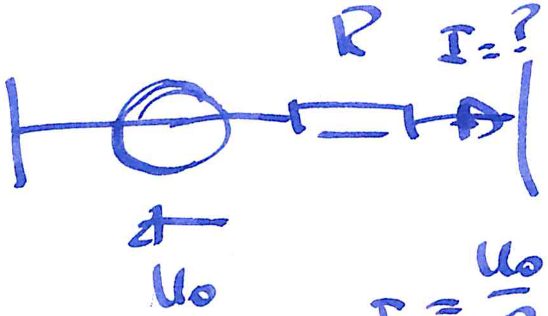
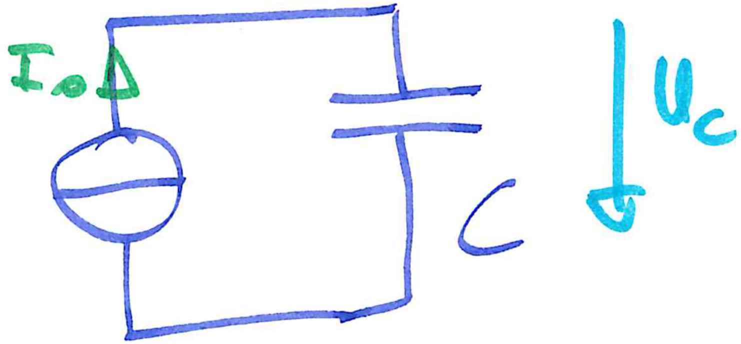


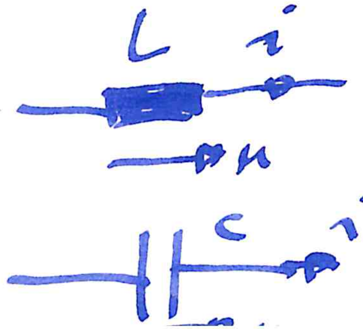
$I = \frac{U_0}{R}$

App.:



Equation of C:

$$\begin{cases} u = L\frac{di}{dt} \\ i = C\frac{du}{dt} \end{cases}$$



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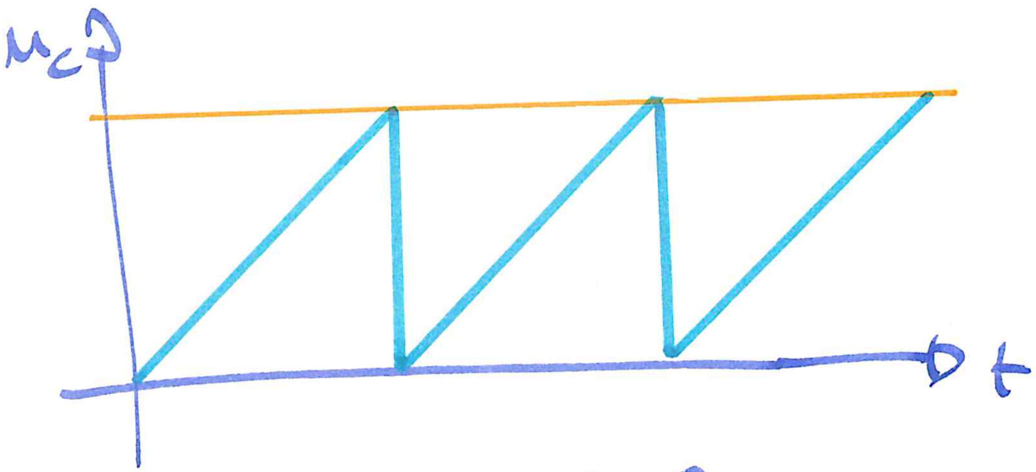
$$\int i\,dt = \int C \frac{du}{dt}\,dt = C \int \frac{du}{dt}\,dt$$

$$= C \int du = Cu$$

$$u = \frac{1}{C} \int i\,dt$$

($i \rightarrow I_0$)

$$u = \frac{1}{C} I_0 \int dt = \frac{1}{C} I_0 \cdot t$$



saw-tooth-diagram ~~saw teeth~~ ~~saw-teeth-diagram~~

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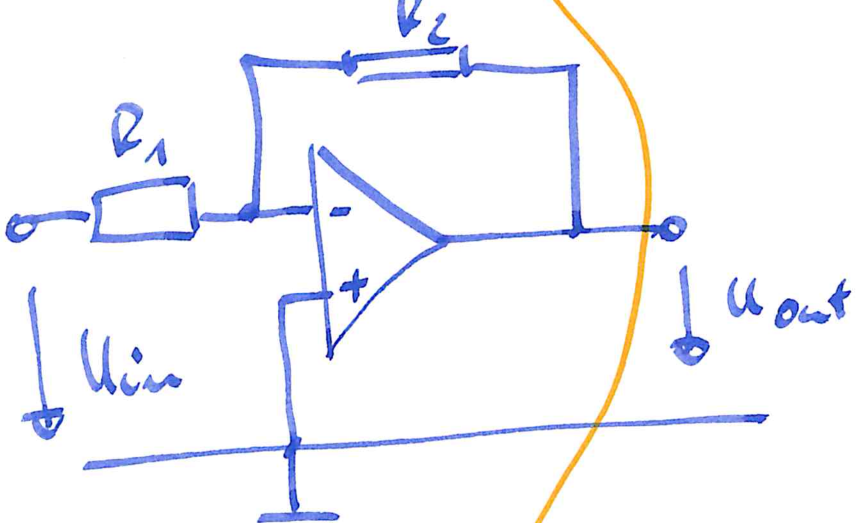
2.) ~~Si~~ Simple amplifier

– Inverter



$$U_{out} = -\frac{R_2}{R_1} \cdot U_{in}$$

Examples: Lot of ...

3.) Impedance transformer

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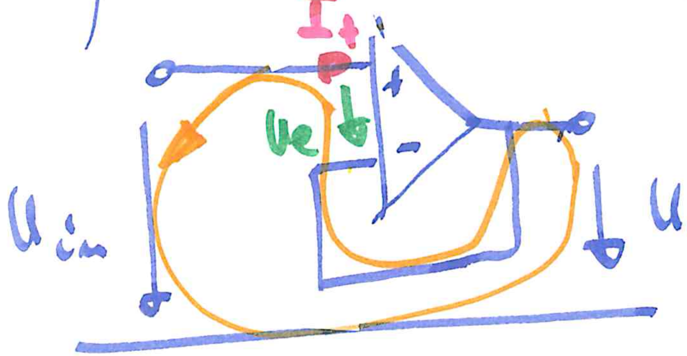

$U_e \simeq 0$!

if the output goes to the inverting input ! ⇒ negative feedback

$U_{in} - U_{out} - U_e = 0$

$U_{out} = U_{in}$

$I_+ \simeq 0$

$\Rightarrow Z_{in} = \frac{U_{in}}{I_+} \simeq \infty$

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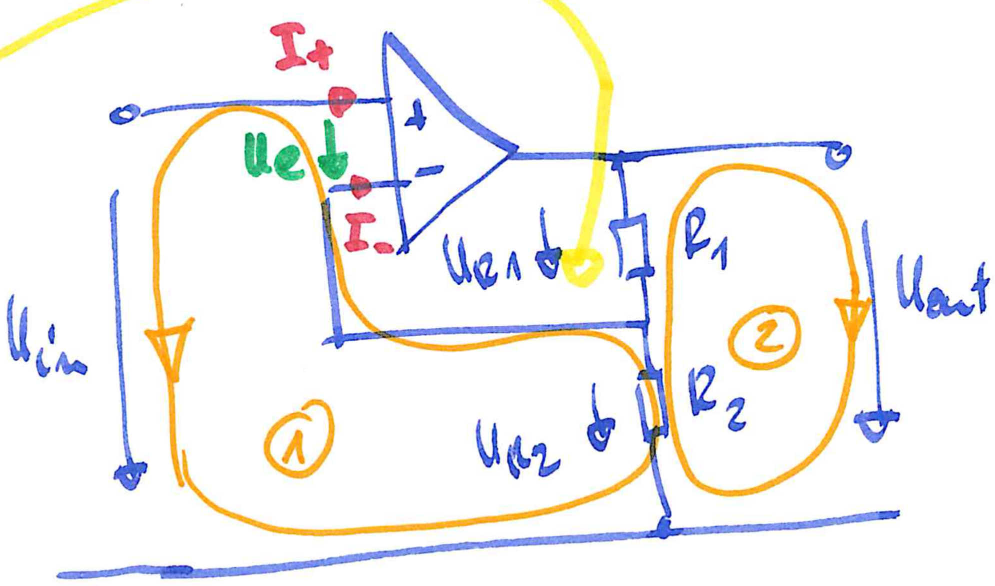
$$\frac{2V\ \Omega}{10^{-10} A} = \frac{2}{10^{-10}} = 2 \cdot 10^{10}$$

Impedance Transformer

Impedance = Resistance

4.) Non Inverter



$I_+ \approx 0 \; ; \; I_- \approx 0$

(1)

$U_{in} - U_{R2} - U_e = 0$

$U_e \approx 0$

$U_{in} = U_{R2}$

(2) $-U_{R1} - U_{R2}$ U_{out}

$U_{out} - U_{R2} - U_{R1} = 0$

$U_{out} - U_{in} - U_{R1} = 0$

$U_{R1} = \frac{R_1}{R_1 + R_2} \cdot U_{out}$

$U_{out}\left(1 - \frac{R_1}{R_1 + R_2}\right) = U_{in}$

$U_{out} = \frac{1}{1 - \frac{R_1}{R_1 + R_2}} \cdot U_{in}$

$= \frac{R_1 + R_2}{R_1 + R_2 - R_1} \cdot U_{in}$

$= \frac{R_1 + R_2}{R_2} \cdot U_{in}$

$$U_{out} = \left(1 + \frac{R_1}{R_2}\right) U_{in}$$

Non Inverter