Budapest University of Technology and Economics
Faculty of Transportation Engineering and Vehicle Engineering
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Electronics - electronic measuring systems

Transistor example, rectifiers, operational amplifiers

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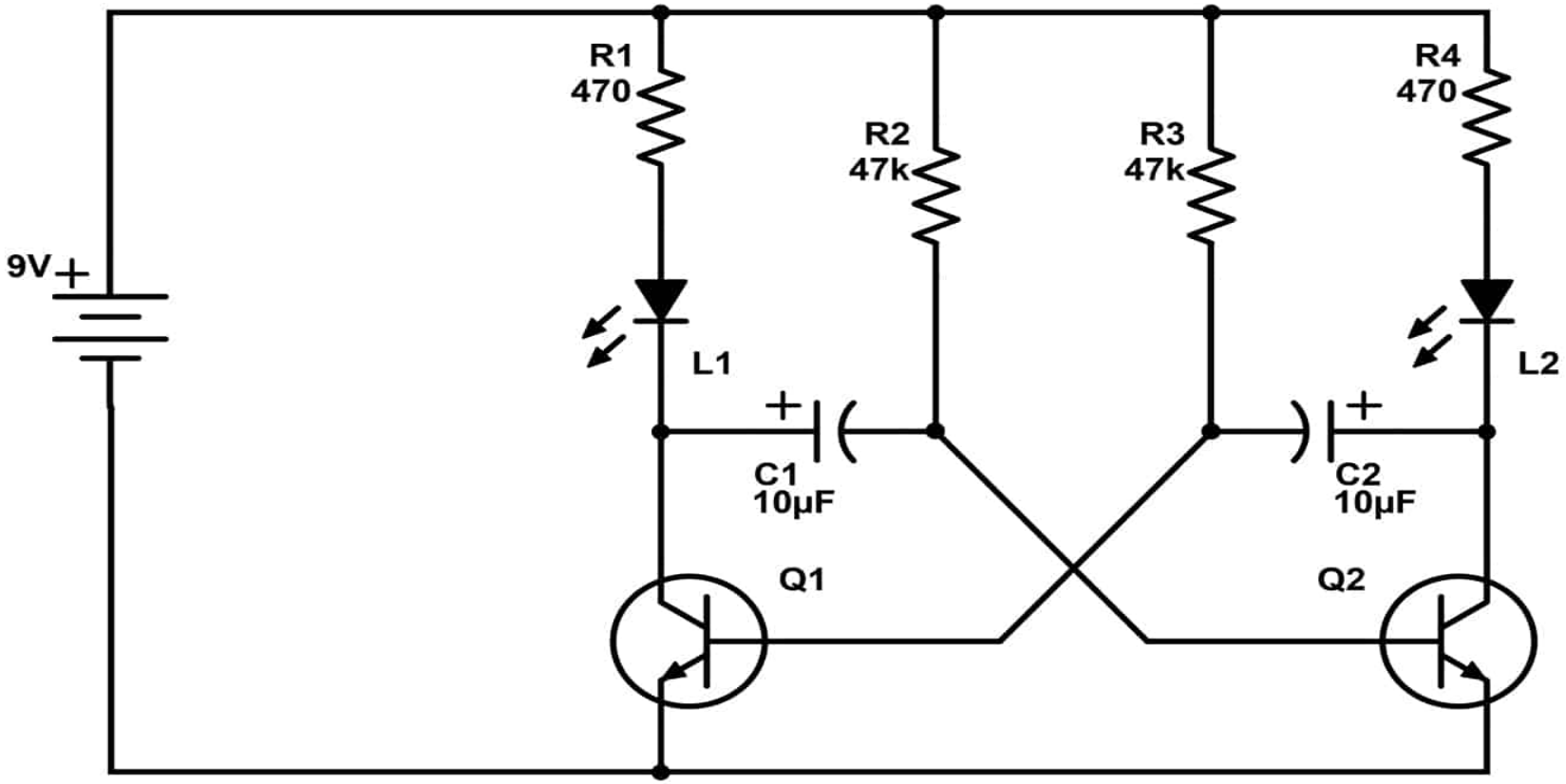
Astable Multivibrator

The astable multivibrator circuit is a classic circuit for flashing two LEDs

- L1, L2 - LEDs
- R1,R4 - resistors

to set LED current

- Q1, Q2 - transistors
- C1, C2 - capacitors
- R2, R3 - resistors



Astable multivibrator (2)

- The Light-Emitting Diode (LED) on the left side is lit when the transistor on the left side (Q1) is ON.
- The LED on the right side is lit when the transistor on the right side (Q2) is ON.
- Both Q1, Q2 try to open at start, due to irregularities in the materials one will open faster.

Astabil Multivibrator (3)

Short explanation:

- The voltage on the left side of C2 controls transistor Q1.
- The voltage on the right side of C1 controls transistor Q2.
- When transistor Q1 turns ON, it changes the voltage of C1 so that Q2 turns off.
- After a short while, the voltage of C1 rises back up and turns on the transistor Q2.
- When transistor Q2 turns on, it changes the voltage of C2 so that Q1 turns off.
- This keeps repeating.

Rectifiers

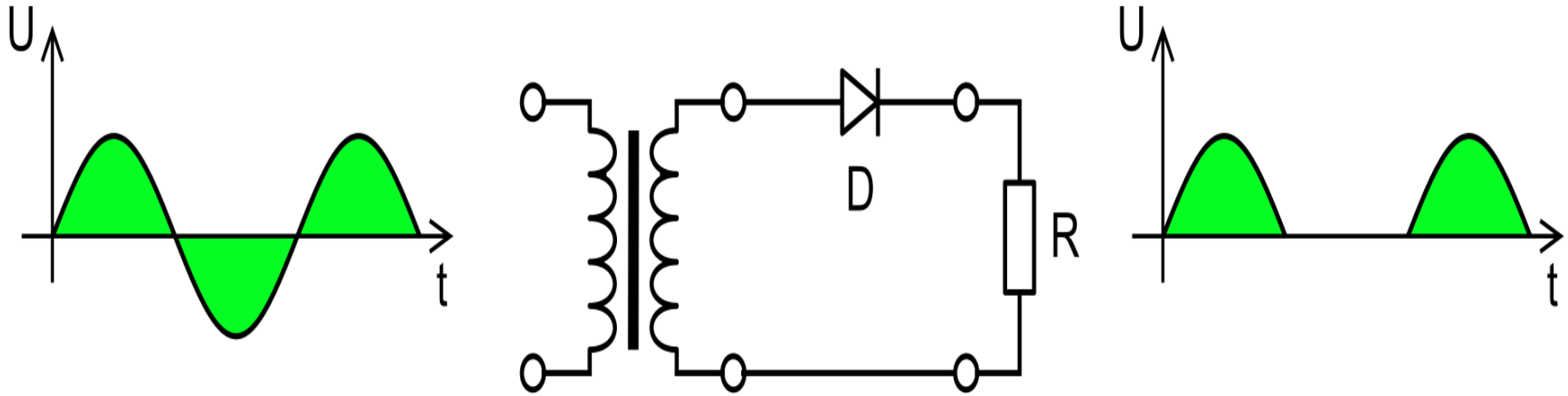
- Electrical device that converts alternating current (AC) to direct current (DC).
- Semiconductor diodes of various types (junction diodes, Schottky diodes, etc.).
- High-power rectifiers employ silicon semiconductor devices of various types (thyristors for example).
- Rectifiers may be single-phase or multi-phase.

Rectifiers (2)

Single-phase half-wave rectifier

- single-phase supply, either the positive or negative half of the AC wave is passed, while the other half is blocked
- one phase with a diode
- one half of the input waveform reaches the output

Rectifiers (3)



$$\mathrm{Vdc} = \frac{\mathrm{Vpeak}}{\pi}$$

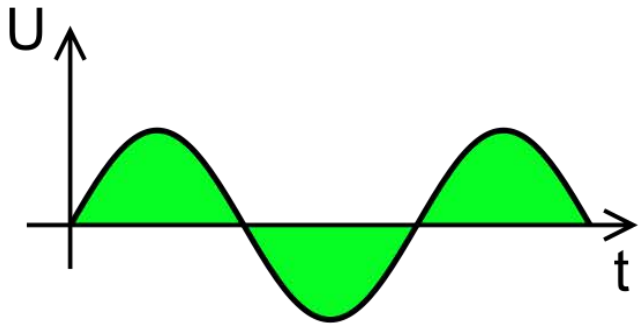
Rectifiers (4)

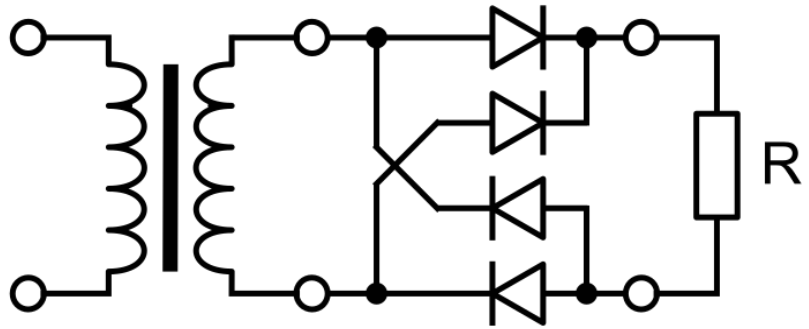
Single-phase full-wave rectifier

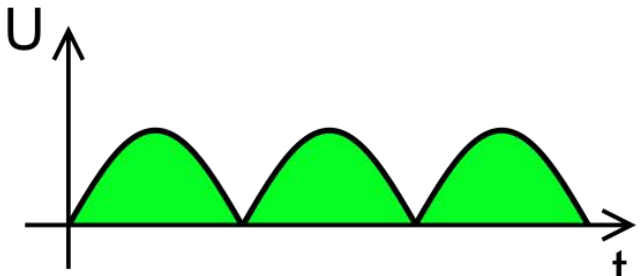
- whole of the input waveform to one of constant polarity (positive or negative) at its output
- two diodes and a center tapped transformer, or four diodes in a bridge configuration and any AC source
- Converts both polarities of the input waveform to pulsating DC

Rectifiers (5)

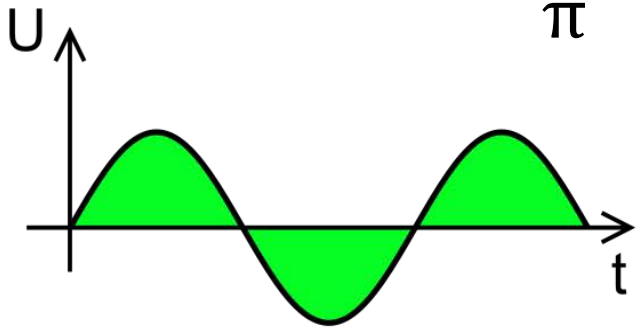
- Graetz-bridge

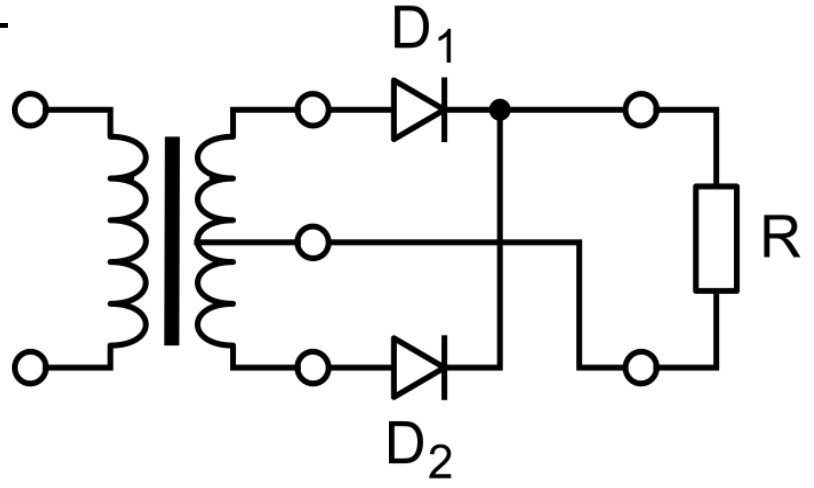


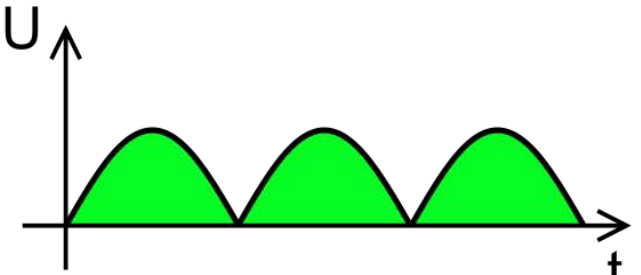




$$Vdc = \frac{2 * Vpeak}{\pi}$$



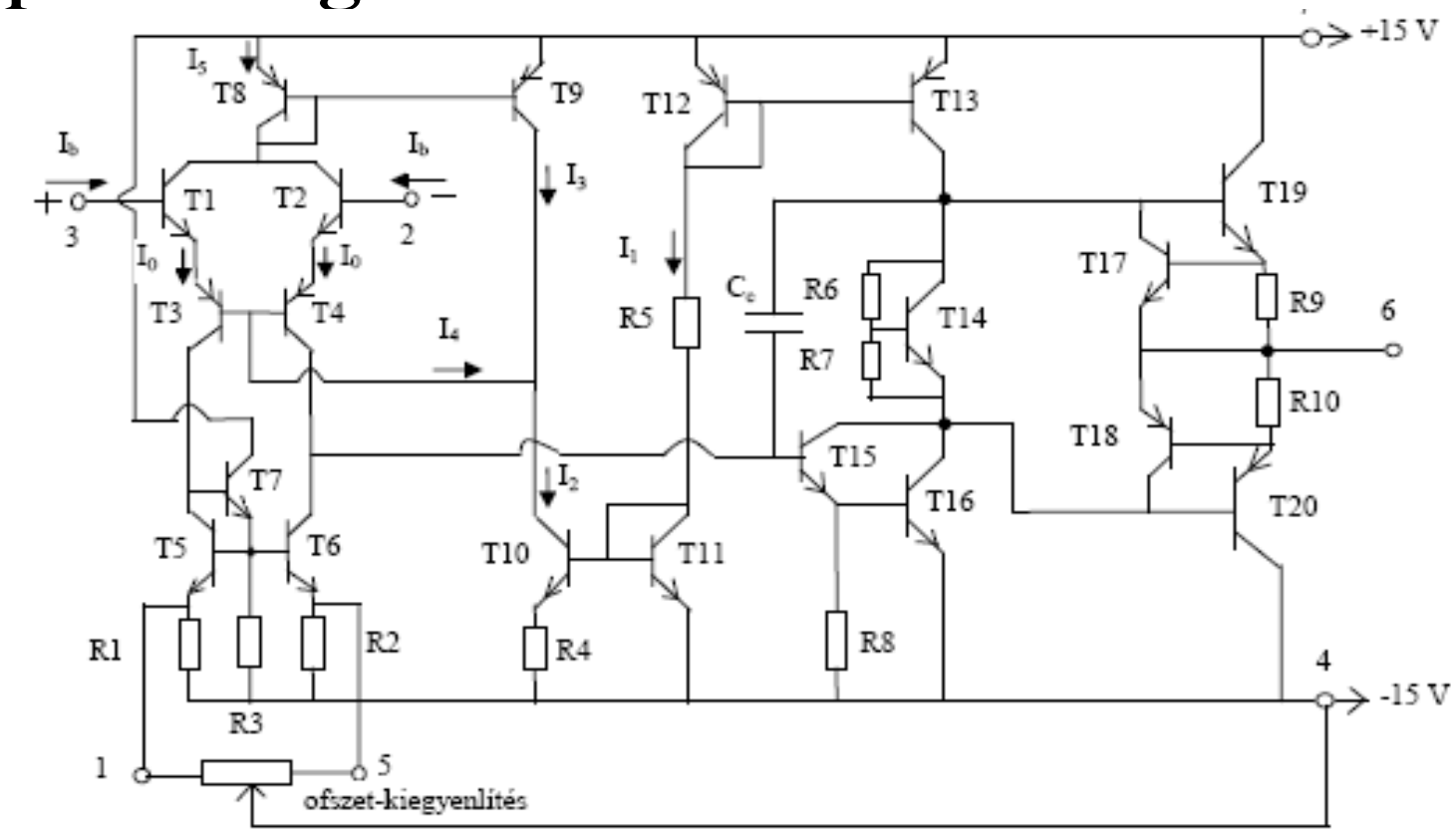




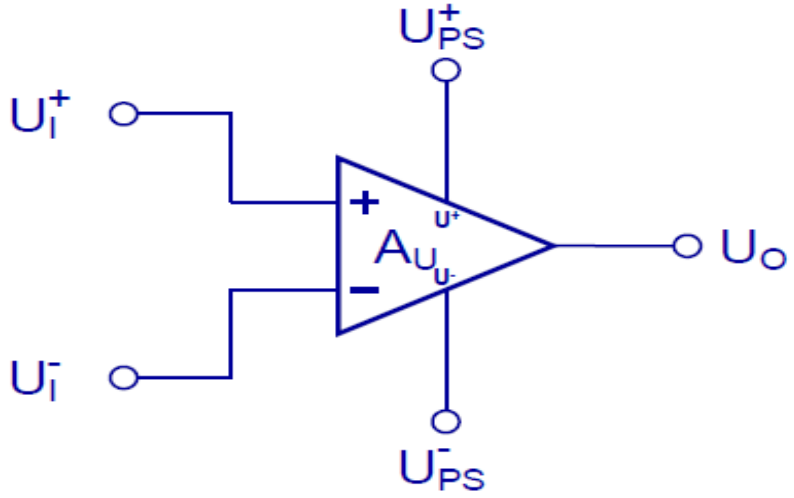
Amplifiers

Amplify input voltage or current

Operational amplifier

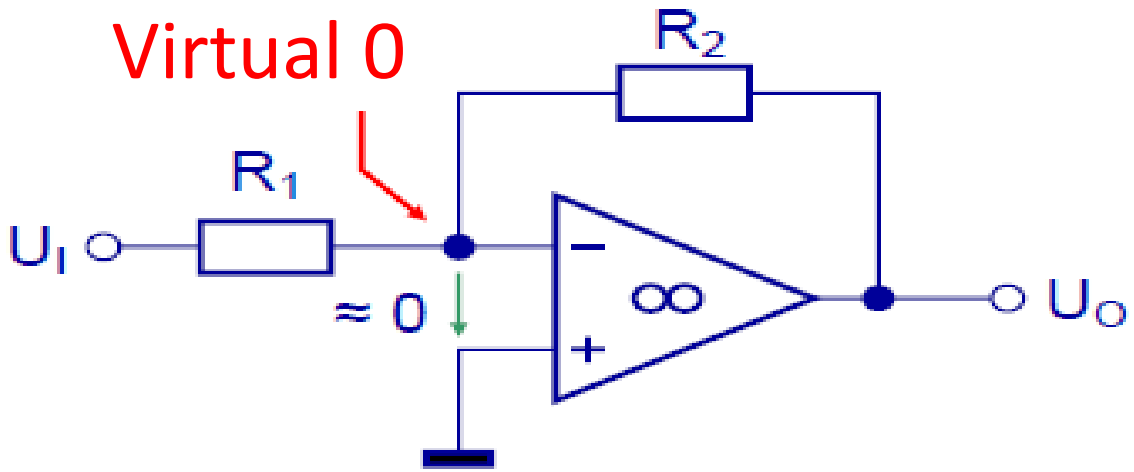


Operational amplifiers



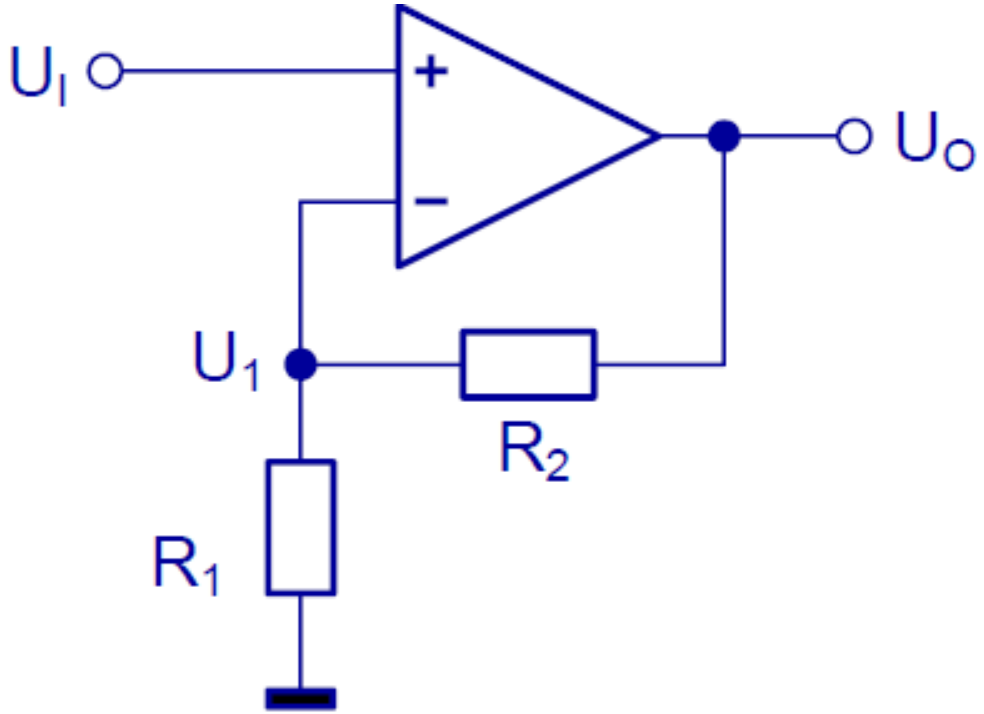
- Amplify small amplitude signals
- Signal manipulation
- Signal to noise (SNR) ration manipulation
- $Uo = A*(Ui^{+} - Ui^{-})$
- A – voltage amplification (very large - $10^4 - 10^8$)
- No input current
- Rb – input resistance (very large - $10^4 - 10^8$)

Inverting amplifier



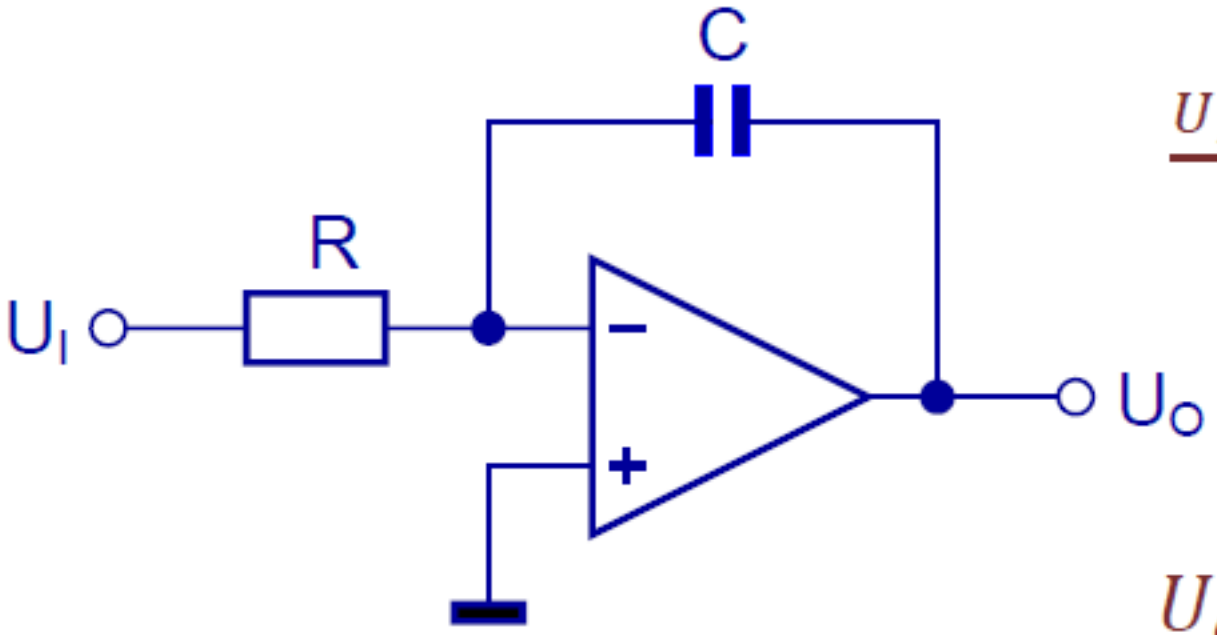
$$\mathrm{Uo} = -\frac{R2}{\mathrm{R1}} * Ui$$

Non-inverting amplifier



$$\mathrm{Uo}=(1+\frac{R2}{\mathrm{R1}})*Ui$$

Integrator



$$\frac{U_I(s)}{R} + sCU_O(s) = 0$$

$$U_O(s) = -\frac{1}{sRC}U_I(s)$$

$$U_O(t) = -\frac{1}{RC}\int_0^t U_I(\tau)d\tau$$