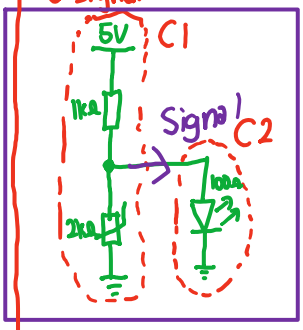
Operational Amplifiers

Tuesday, 20 January 2026 09:51

Definitions

- Loading Effect
  - Effect of a load on a signal
  - Distorts incoming signal
  - The lower the resistance, the higher the loading effect
  - The higher the current drawn, the higher the loading effect
- Input Impedance
  - Impedance is the resistance 'seen' by a signal



In this case, the LED Resistance is C2's input impedance (100Ω)

Not in Syllabus

Simplified explanation of impedance

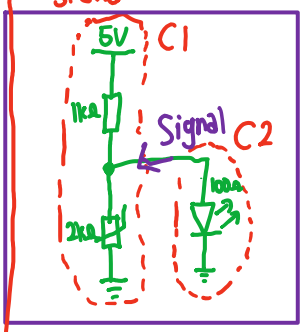
↓

Consists of factors

Resistance | Capacitance | Induction

Under AC conditions

  - Higher input impedance is Better!
    - Lower Distortion by previous stage
    - Reduce loading effect
- Output impedance
  - The resistance seen by an incoming signal

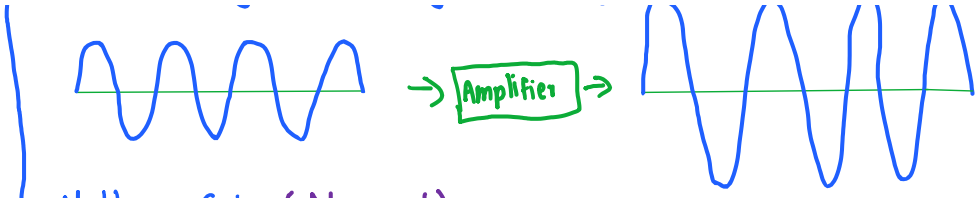


In this case, C1's output impedance is $1k\Omega + 2k\Omega = 3k\Omega$

  - Lower Output Impedance is better!
    - Reduce distortion by next stage
    - Able to supply higher current to next stage

Amplifiers

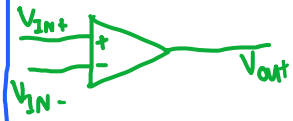
- Increases magnitude of Signal's Voltage/Current/Power



- Voltage Gain (No unit)
  - A_V, the increase of the $\frac{V_{out}}{V_{in}}$
  - $A_V = \frac{V_{OUT}}{V_{IN}}$
- Uses
  - When small signals need to be made bigger
    - Audio amp
    - Heartbeat monitor

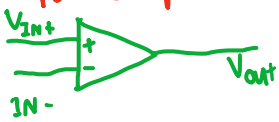
Op-Amp

- Has High Input Impedance (in MΩ)
  - Draws low current
  - Very low loading effect
- Negligible Output Impedance
- Symbol



V_{IN+}	Non-Inverting Input
V_{IN-}	Inverting Input
V_{out}	Output

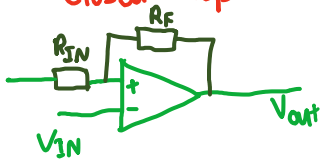
- Amplification
  - Amplifies The difference between V_{IN+} and V_{IN-}
  - Has limit of V_{cc} - 1.5V ☆ Even if A_{OL} is higher!
- Configurations
  - Open Loop



A_{OL}	Open loop gain

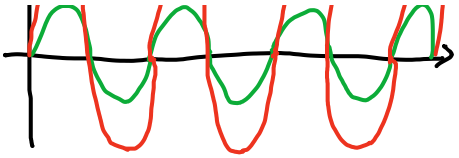
☆ Rarely Used. A_{OL} is too High → Stuck at HIGH or LOW

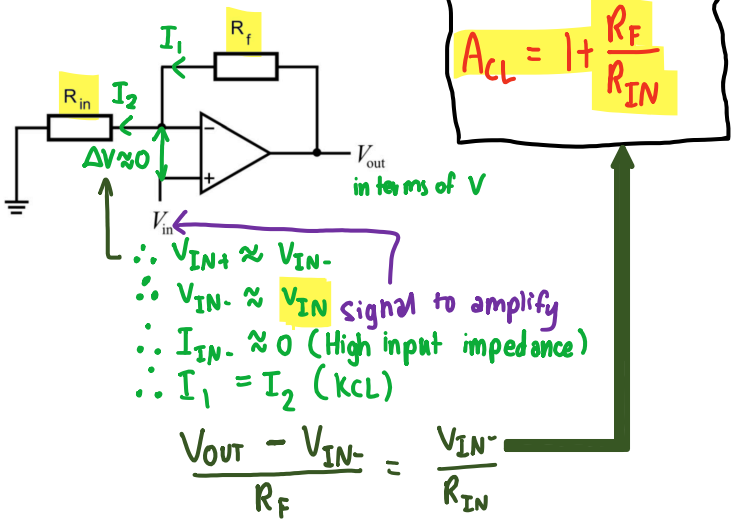
  - Closed Loop



A_{CL}	Closed Loop Gain
R_{IN}	Resistor at input
R_F	Feedback Resistor

- Types
  - Non-Inverting Amplifier





Voltage Follower

- Has ideal A_{CL} of 1
  - Input voltage = Output voltage
- ↑↑ Input impedance
- ↓↓ Output impedance
  - ↓↓ Loading effect