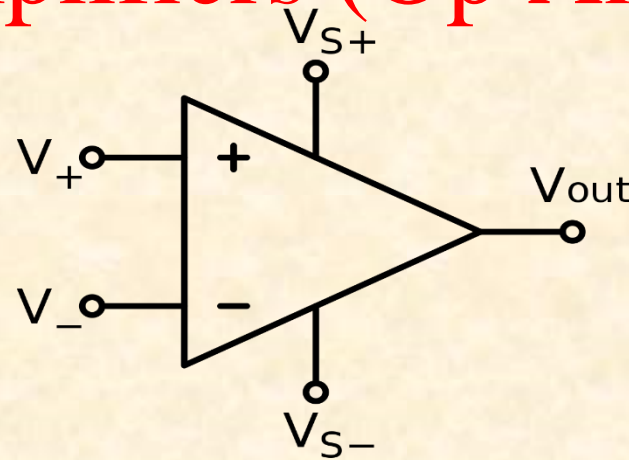
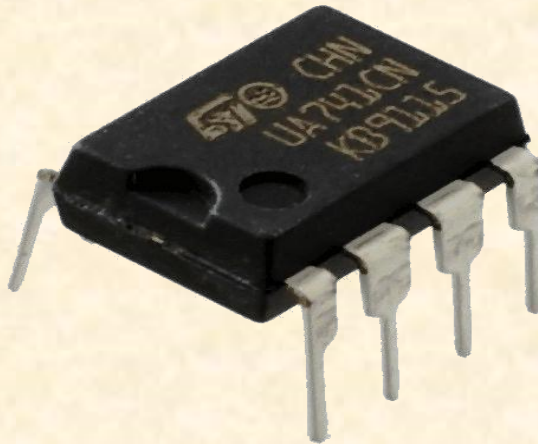


# Second stage : Power electronics



## Operational Amplifiers (Op Amps)



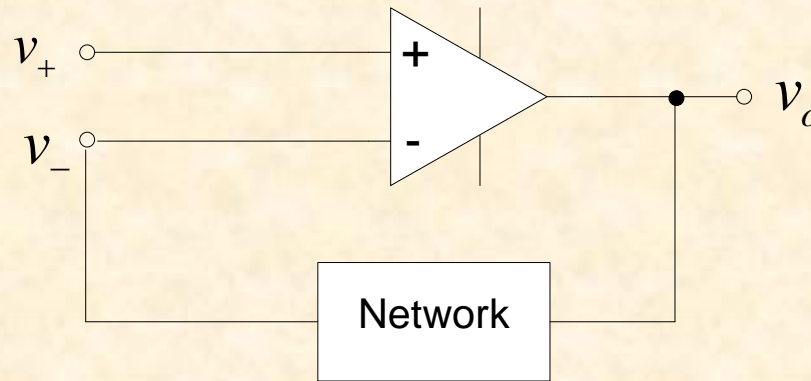
Abdul ghafor Abdul Ghafar

Abdul hameed

# Outline

- Ideal Op Amp
- Inverting Amplifier
- Non-inverting Amplifier
- Example & Quiz
- References & contacts

# Ideal Op Amp with Negative Feedback

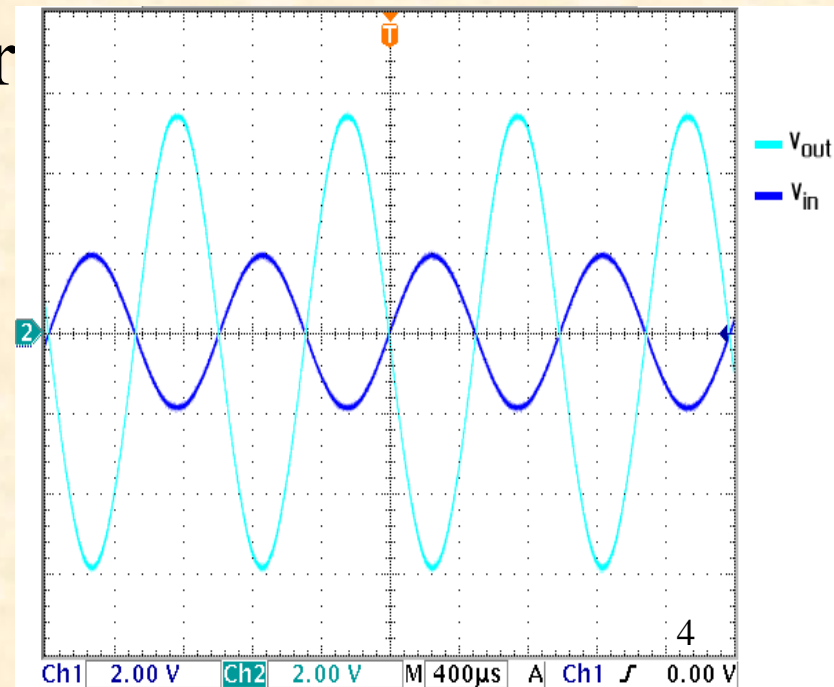


## Golden Rules of Op Amps:

1. The output attempts to do whatever is necessary to make the voltage difference between the inputs zero.
2. The inputs draw no current.

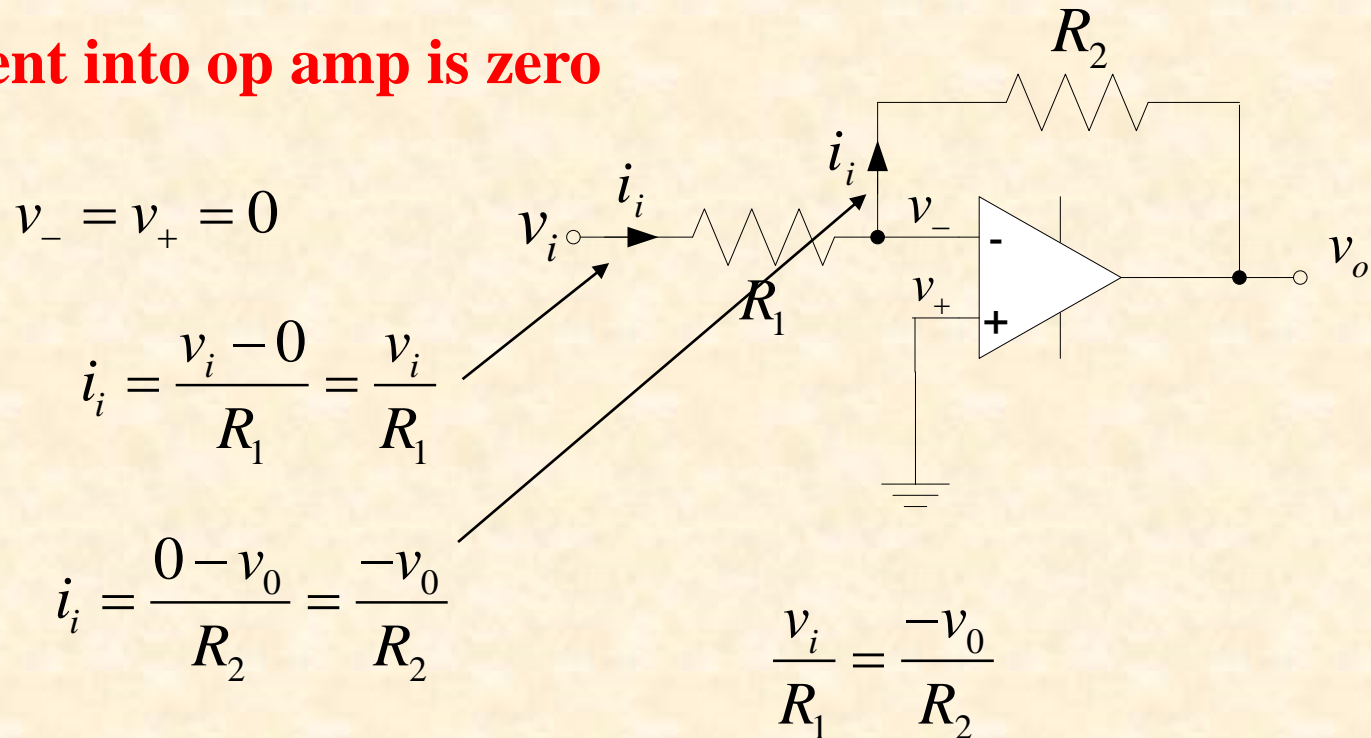
# Operational Amplifiers (Op Amps)

- ideal Op Amp
- **Inverting Amplifier**
- Non-inverting Amplifier
- Example & Quiz



# Inverting Amplifier

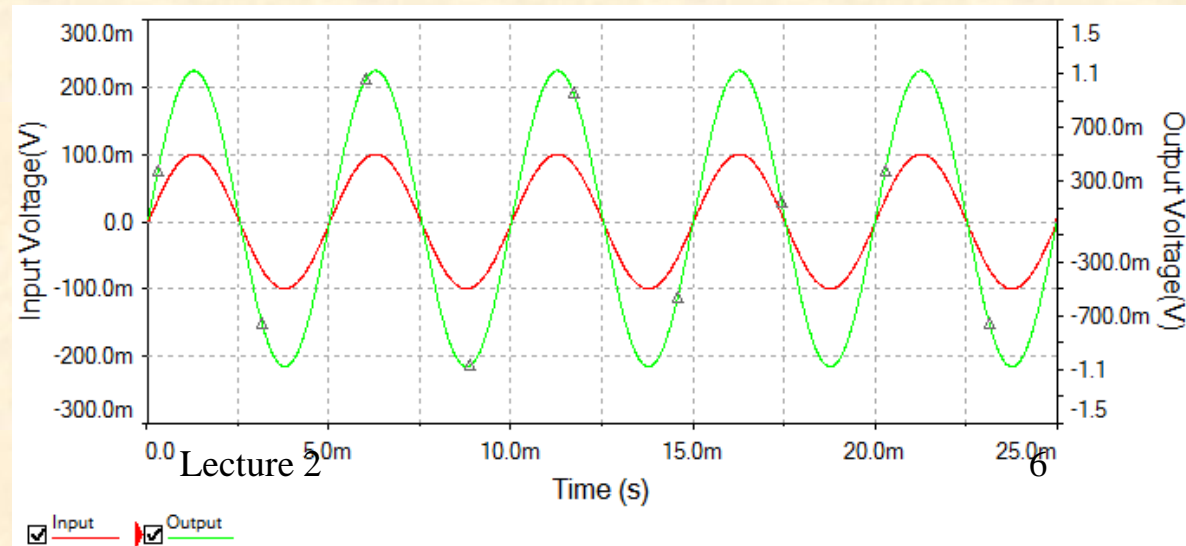
Current into op amp is zero



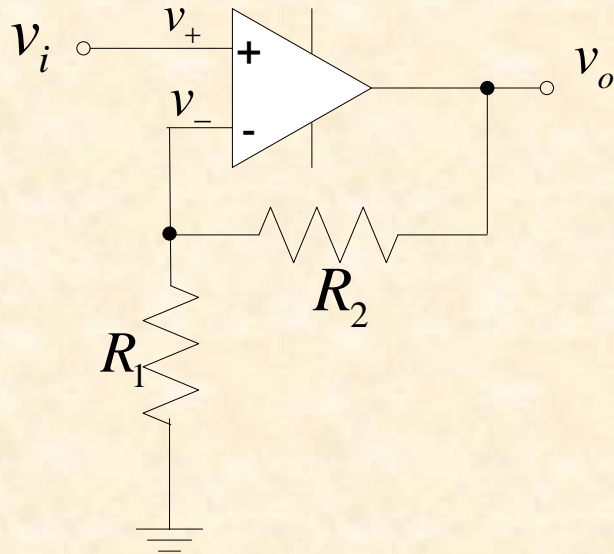
$$A_F = \frac{v_o}{v_i} = -\frac{R_2}{R_1}$$

# Cont.

- ideal Op Amp
- Inverting Amplifier
- **Non-inverting Amplifier**
- Example & Quiz
- full wave rectifier



# Non-inverting Amplifier



**Current into op amp is zero**

$$v_+ = v_- = v_i$$

$$A_F = \frac{v_o}{v_i}$$

$$v_i = v_+ = v_- = \frac{R_1}{R_1 + R_2} v_o$$

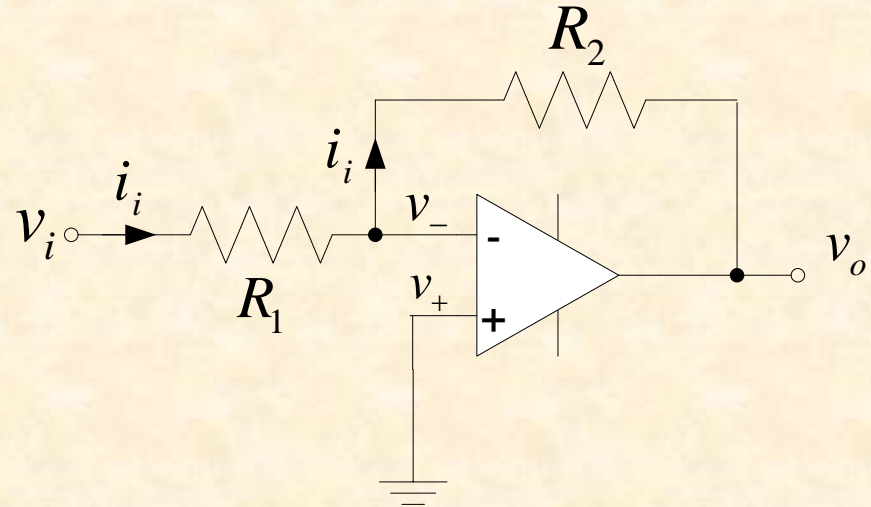
$$A_F = \frac{v_o}{v_i} = 1 + \frac{R_2}{R_1}$$



# EXAMPLE & QUIZ

**EX.** For the inverting Op-Amp in bellow. Find the gain voltage if  $v_i=5v$ ,  $R_1=2\Omega$  and  $R_2 = 10\Omega$

$$A_F = \frac{v_o}{v_i} = -\frac{R_2}{R_1}$$



**Then**  $A_F = \frac{10}{2} = 5$

**Quiz.** For the above value of resistances find the gain voltage for non-inverting Op-Amp.

Sol.  $A_F=6$



## REFERENCES AND CONTACTS:

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HOROWITZ, P., ET AL. (1980). THE ART OF ELECTRONICS,  
CAMBRIDGE UNIVERSITY PRESS CAMBRIDGE.

### CONTACTS:

[HTTPS://SITES.GOOGLE.COM/VIEW/ABDULGHAFOR-A-ABDULHAMEED](https://sites.google.com/view/abdulghafor-a-abdulhameed)

EMAIL: [ABDULGAFOORABD@YAHOO.COM](mailto:ABDULGAFOORABD@YAHOO.COM)

GMAIL: [ABDALGHFORABDALGHFAR@GMAIL.COM](mailto:ABDALGHFORABDALGHFAR@GMAIL.COM)