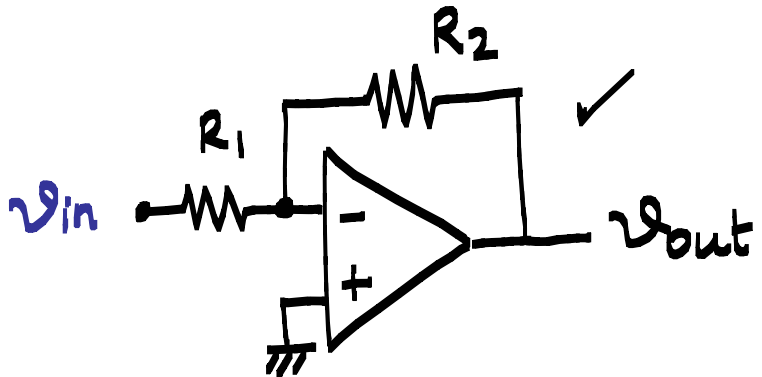
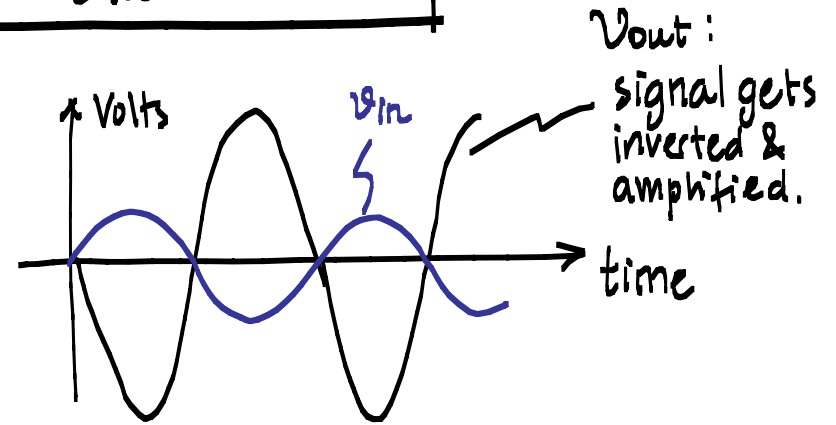


# BRIEF CONTACT WITH AMPLIFIER DESIGN

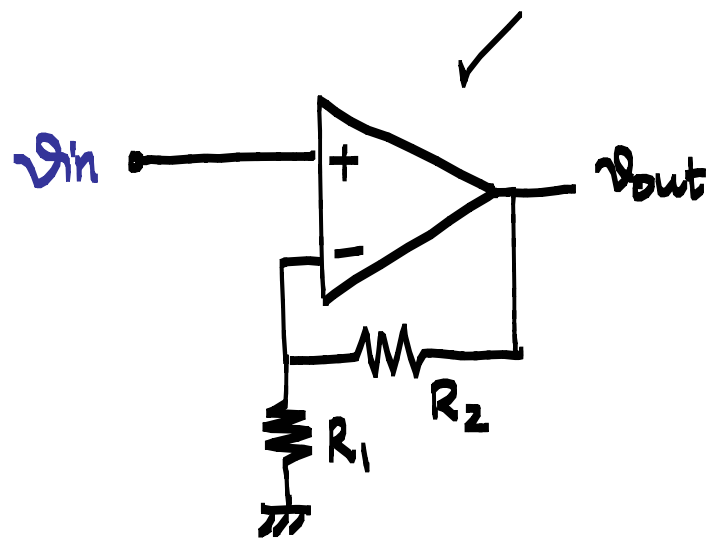
## INVERTING AMPLIFIER



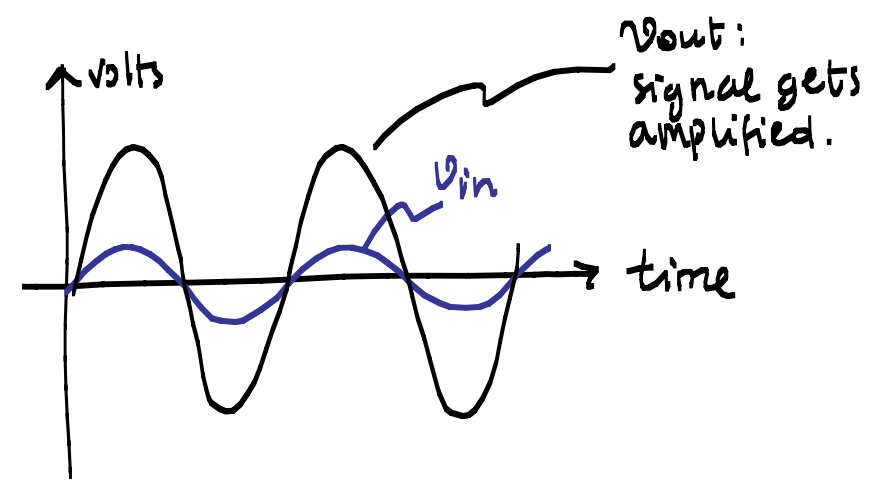
$$\text{Gain: } \frac{V_{out}}{V_{in}} = -\frac{R_2}{R_1}$$



## NON-INVERTING AMPLIFIER

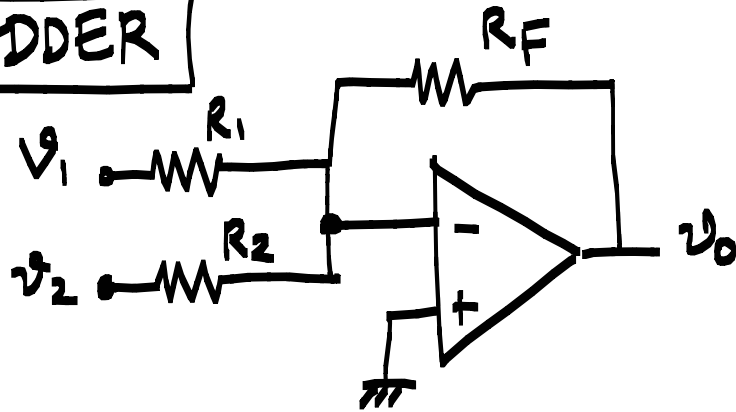


$$\text{Gain: } \frac{V_{out}}{V_{in}} = 1 + \frac{R_2}{R_1}$$



# BRIEF CONTACT WITH AMPLIFIER DESIGN

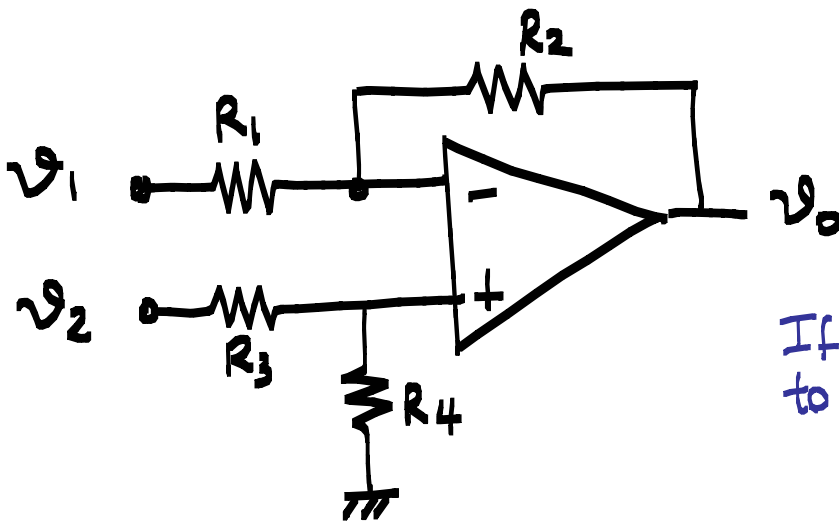
## ADDER



$$v_o = v_1 \left( -\frac{R_F}{R_1} \right) + v_2 \left( -\frac{R_F}{R_2} \right)$$

Use this topology to amplify the sum of two signals

## DIFFERENTIAL AMPLIFIER

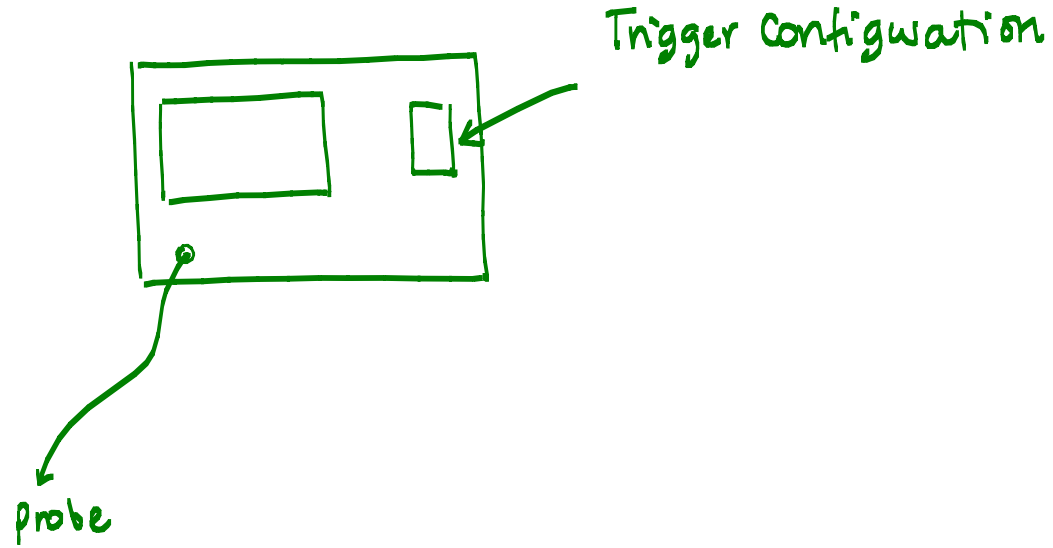
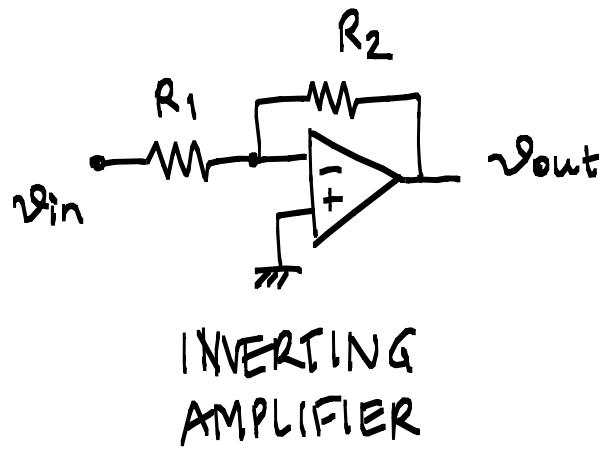


$$v_o = v_2 \left[ \frac{R_4}{R_3 + R_4} \right] \left[ 1 + \frac{R_2}{R_1} \right] - v_1 \frac{R_2}{R_1}$$

If  $v_2$  is a DC value, you could use this topology to add an OFFSET to a signal

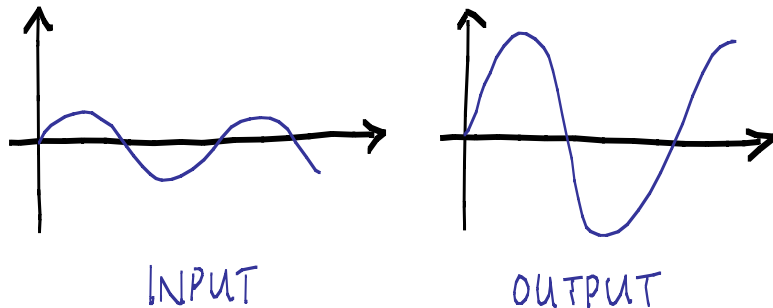
So, for instance, how would a filter followed by an amplifier look like?

Let's discuss a little about the operation of a scope:



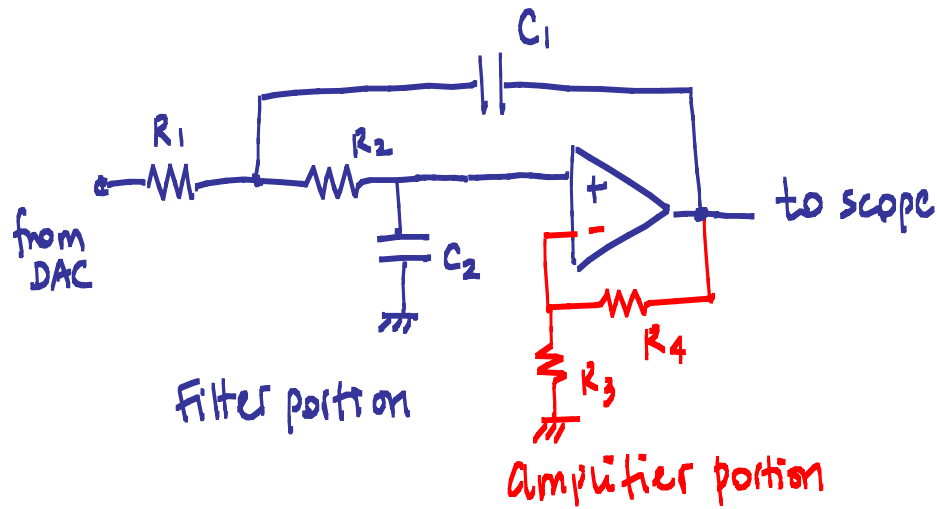
Take, for instance, the following paradox:

One, the same, probe is used in the amplifier above to measure the gain. To our surprise, this is what we see at input & output



SOLUTION:

**Another question:** Can we merge the filter and the amplifier using only ONE OPAMP?



$$f_0 = \frac{1}{2\pi} \sqrt{\frac{1}{R_1 R_2 C_1 C_2}}$$

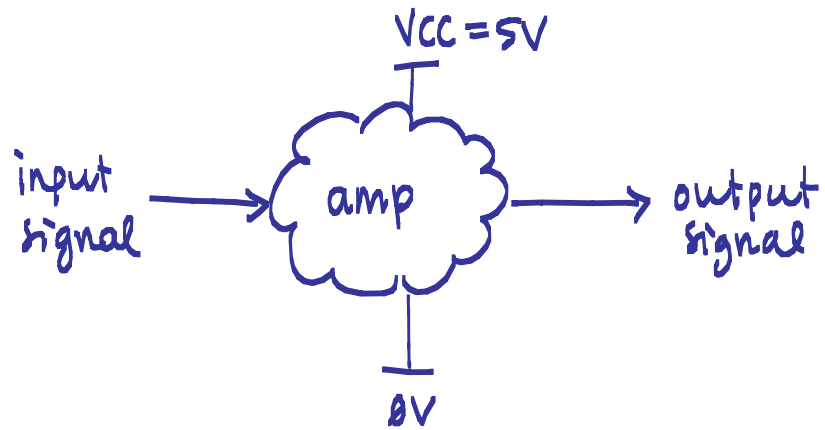
$$Q = \frac{1}{\sqrt{\frac{R_2 C_2}{R_1 C_1}} + \sqrt{\frac{R_1 C_2}{R_2 C_1}} + (1-A) \sqrt{\frac{R_1 C_1}{R_2 C_2}}}$$

$$A = 1 + \frac{R_4}{R_3}$$

THIS IS CALLED A BUTTERWORTH SECOND ORDER FILTER WITH GAIN (USING THE SALLEN & KEY TOPOLOGY)

**yet more:** How about a circuit that subtracts the dc voltage from the signal

Here is another way to formulate the same question:



Thus, in case we wanted to implement such feature (been able to see a negative voltage at the output) we have two possibilities: (1) to use negative supplies in the circuit and design the dc subtractor (Highly NON-CONVENIENT & impractical because we would have to carry around extra batteries for the lab) or

(2) We mimic what oscilloscopes do to solve the issue:

