Dr Satvir Singh

LINEAR INTEGRATED CIRCUITS

3-01

DC & AC Amplifiers

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DC Amplifier – Inverting Amplifier

Ideally, operational amplifiers have infinity differential voltage gain, i.e.,

$$A_d = \frac{V_o}{V_+ - V_-} = \infty$$

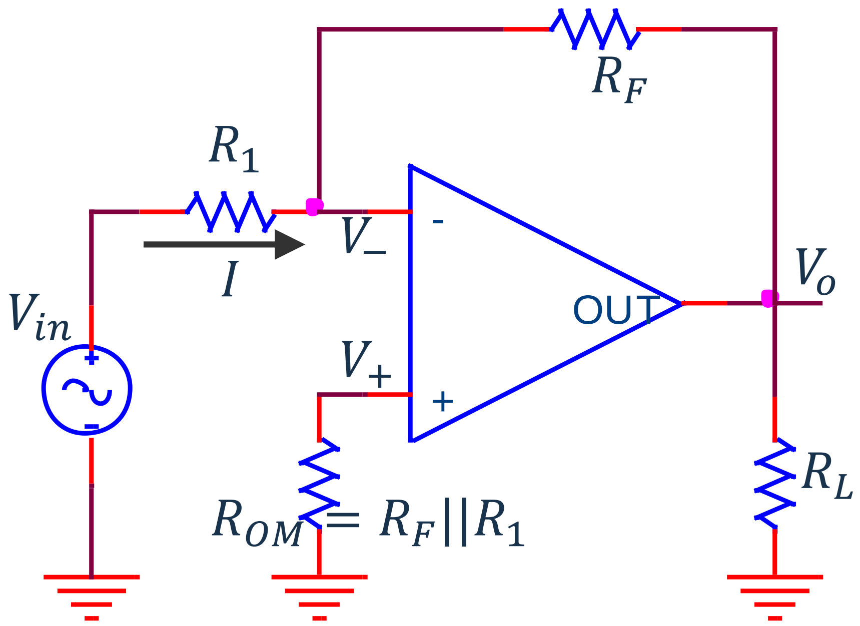
It implies, $V_+ - V_- = 0$ or $V_+ = V_-$

This is called **Virtual Short Circuit**

The current through R_1 is $I = \frac{V_{in}}{R_1}$ and output voltage is given as

$$V_o = -IR_F = -\frac{R_F}{R_1} V_{in}$$

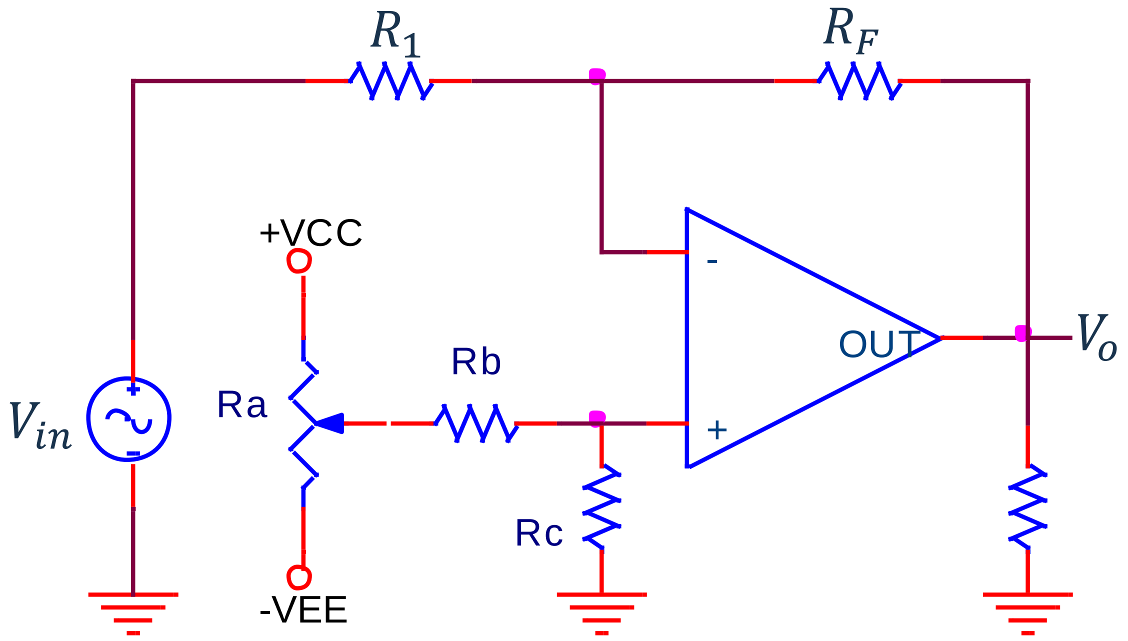
Output inverted and amplified with gain of R_F / R_1



Improved DC Inverting Amplifier

To improve the accuracy of the amplifiers, external compensating network for offset voltage adjustment may used.

Inverting Amplifier



Non-Inverting DC Amplifier

Voltage at non-inverting input terminal given as

$$V_+ = \frac{R_F V_{in}}{R_1 + R_F}$$

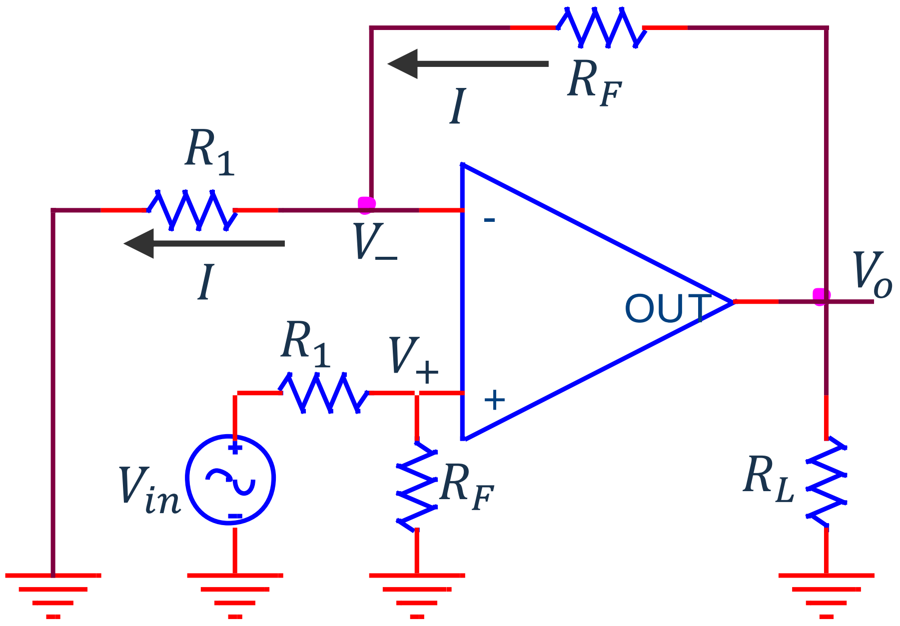
Since $V_+ = V_-$, current flowing through R_1 is $I = \frac{V_-}{R_1}$

The same current flows through R_F, hence

$$V_o = (R_F + R_1)I = (R_1 + R_F)\frac{V_+}{R_1}$$

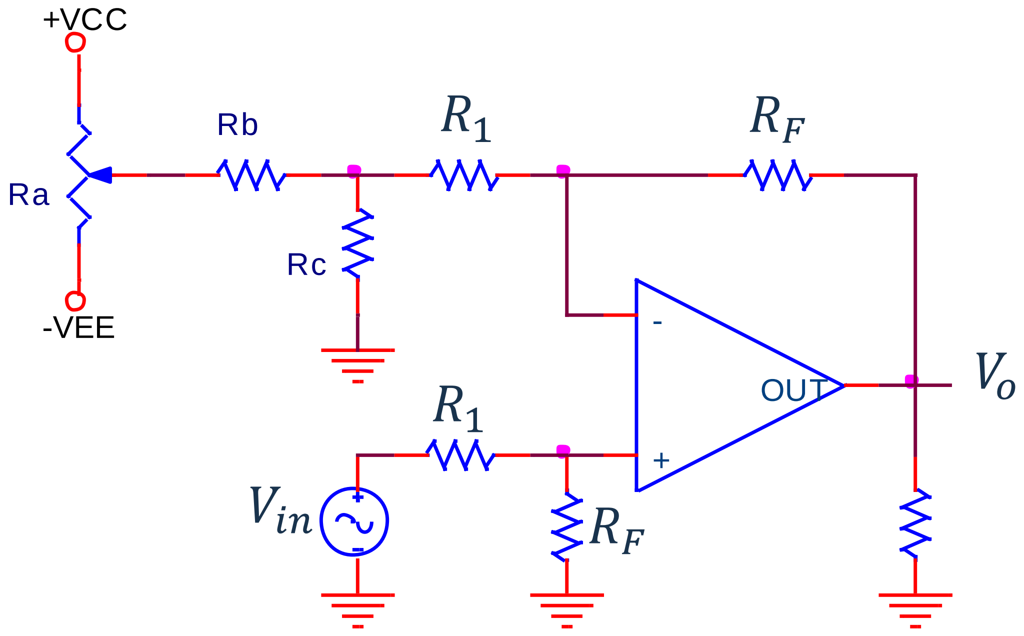
On putting the value of V_+

$$V_o = \frac{R_1 + R_F}{R_1}\frac{R_F V_{in}}{R_1 + R_F} = \frac{R_F}{R_1} V_{in}$$



Improved Non-Inverting DC Amplifier

Non-Inverting Amplifier



Differential DC Amplifier

Since, there are two input voltage sources in the circuit, therefore, we will use Superposition Theorem:

Case I: $V_1 \neq 0$ and $V_2 = 0$

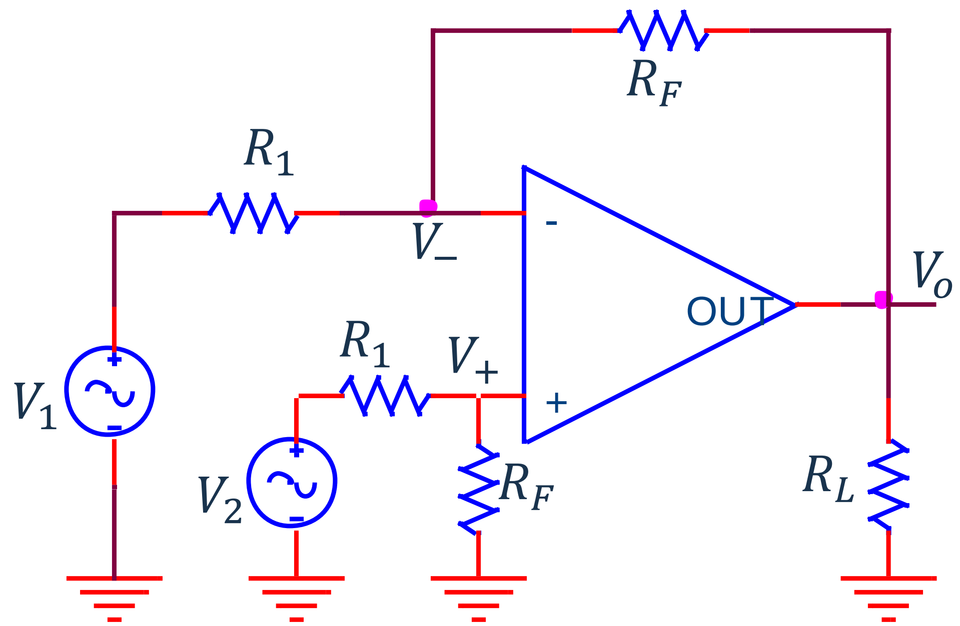
$$V_{o1} = -\frac{R_F}{R_1} V_1$$

Case II: $V_1 = 0$ and $V_2 \neq 0$

$$V_{o2} = \frac{R_F}{R_1} V_2$$

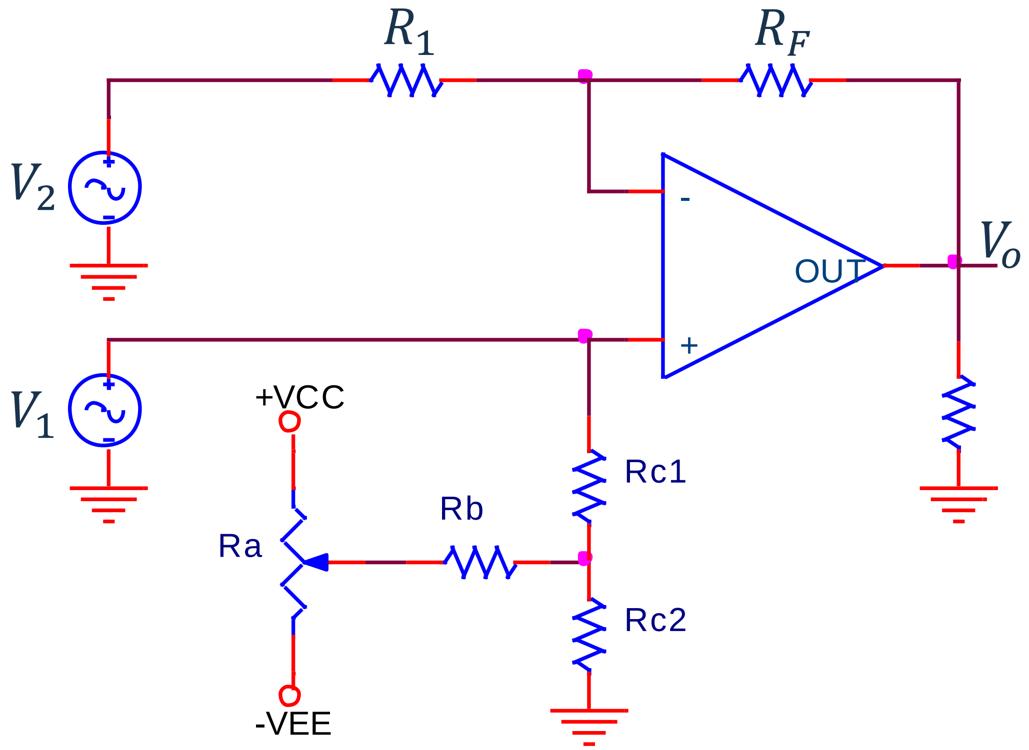
According to Superposition Theorem

$$V_o = V_{o1} + V_{o2} = \frac{R_F}{R_1}(V_2 - V_1)$$



DC Amplifier with Compensating Network

Differential Amplifier

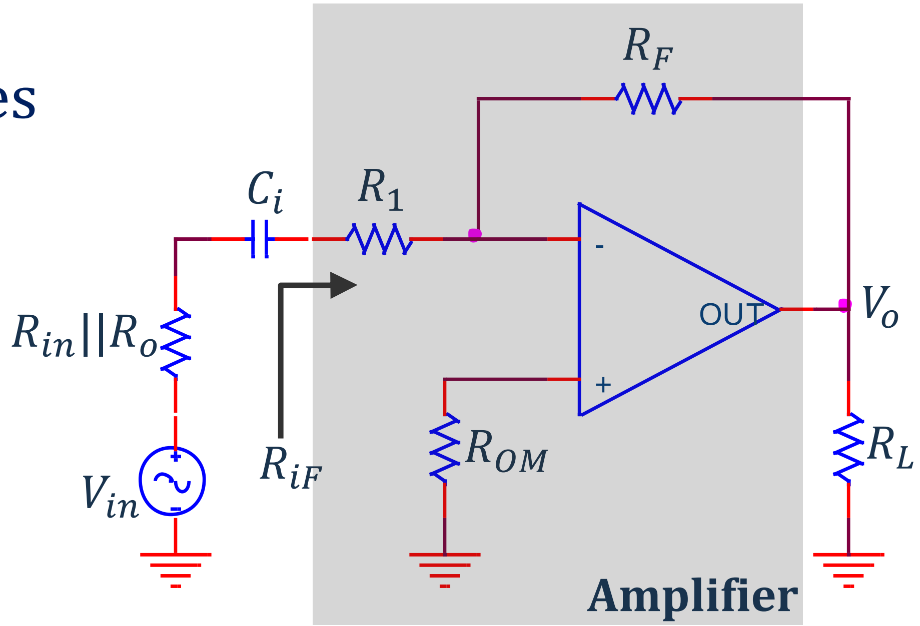


AC Amplifier

AC Amplifiers use input coupling capacitor C_i to pass AC and block DC voltage flowing towards succeeding stages

Cutoff frequency due to C_i is given as

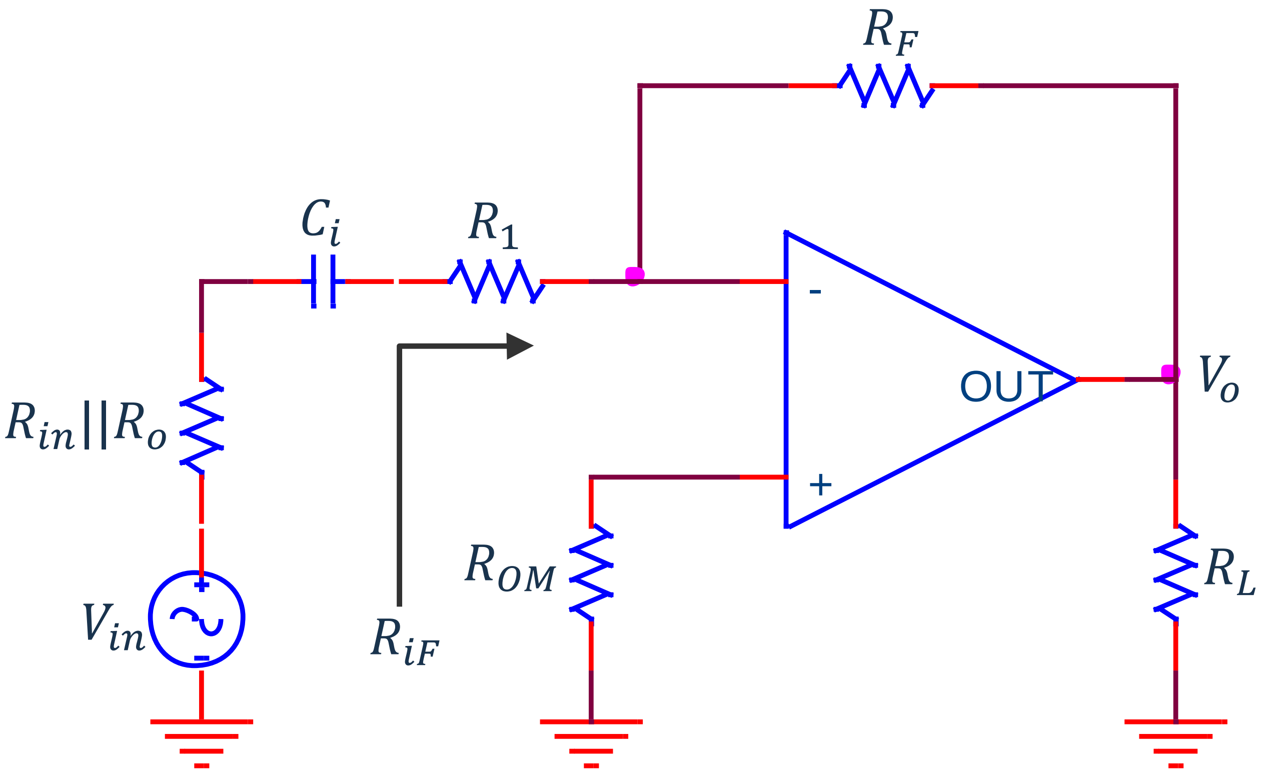
$$f_L = \frac{1}{2\pi C_i(R_o||R_{in}+R_{iF})}$$



Where R_{iF} is input resistance of the next stage and R_{in} source resistance which is in parallel with the output resistance R_o of the previous stage (in case, of voltage amplifiers), if any.

AC Amplifier

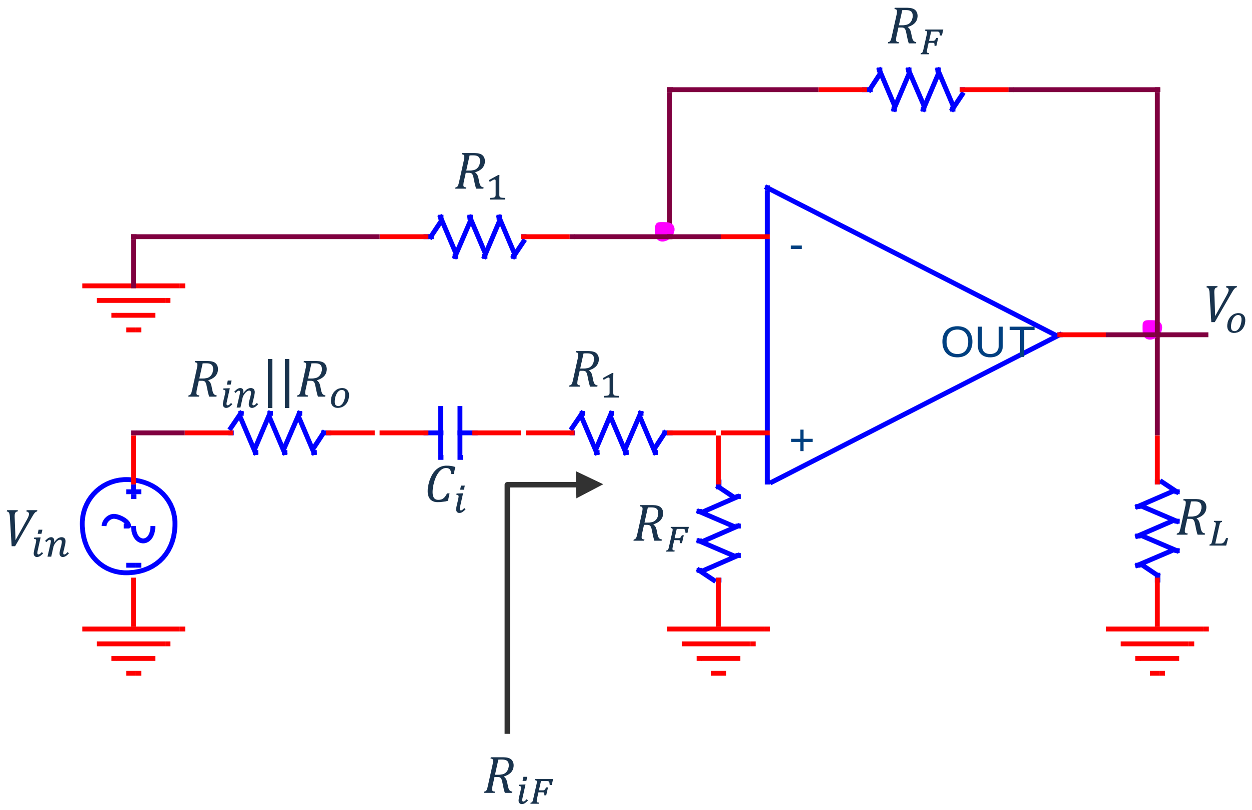
Inverting Amplifier



$$f_L = \frac{1}{2\pi C_i (R_{in} + R_{iF})}$$

AC Amplifier

Non-inverting Amplifier



$$f_L = \frac{1}{2\pi C_i (R_{in} + R_{iF})}$$

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Thank You

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