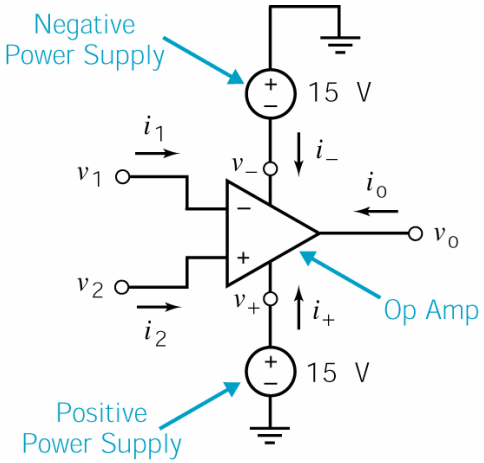
Operational Amplifiers (Op Amps)



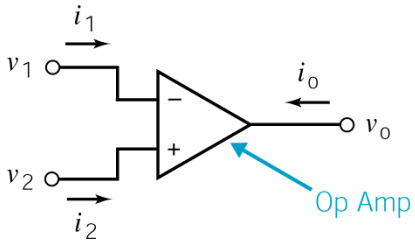
- v_1, v_2, v_o, v_+ and v_- are node voltages. v_1 and v_2 are the input voltages of the op amp. v_o is the output voltage of the op amp. The op amp inputs are distinguished by + and – signs. v_1, the voltage at the node connected to the – input is called the inverting input. v_2, the voltage at the node connected to the + input is called the noninverting input.

- Two power supplies are used to bias the op amp. (The power supplies cause conditions necessary for the op amp to work.) In this case the power supply voltages are $v_+ = 15$ V and $v_- = -15$ V.

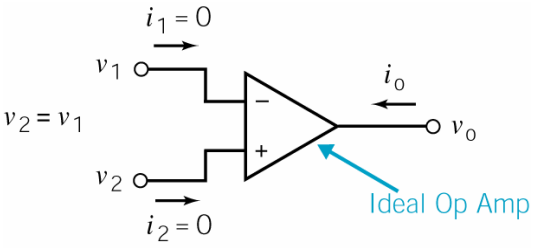
- i_1 and i_2 are the input currents of the op amp. i_o is the output current of the op amp. i_+ and i_- are the power supply currents. From KCL,

$$i_1 + i_2 + i_o + i_- + i_+ = 0 \quad \Rightarrow \quad i_o = -\left(i_1 + i_2 + i_- + i_+\right)$$

- While the power supplies are required to make the op amp work, the power supply currents and voltages are not involved in the equations that describe the working op amp. Also, the power supplies complicate circuit drawings of op amp circuits. For these reasons, the power supplies are frequently omitted from drawing of op amp circuits. It is simply understood that the op amps must be biased by power supplies that are not shown.



- The simplest model of the op amp, and the only model that we will use in this course, is the ideal op amp. The input currents of an ideal op amp are zero and the input voltages are equal.



- With $i_1 = 0$ and $i_2 = 0$

$$i_o = -\left(i_1 + i_2 + i_- + i_+\right) = -\left(i_- + i_+\right)$$

  We seldom know the power supply currents so this equation is rarely use.

- The power received by the op amp is given by $i_o v_o$. The power supplied by the op amp is given by $-i_o v_o$.