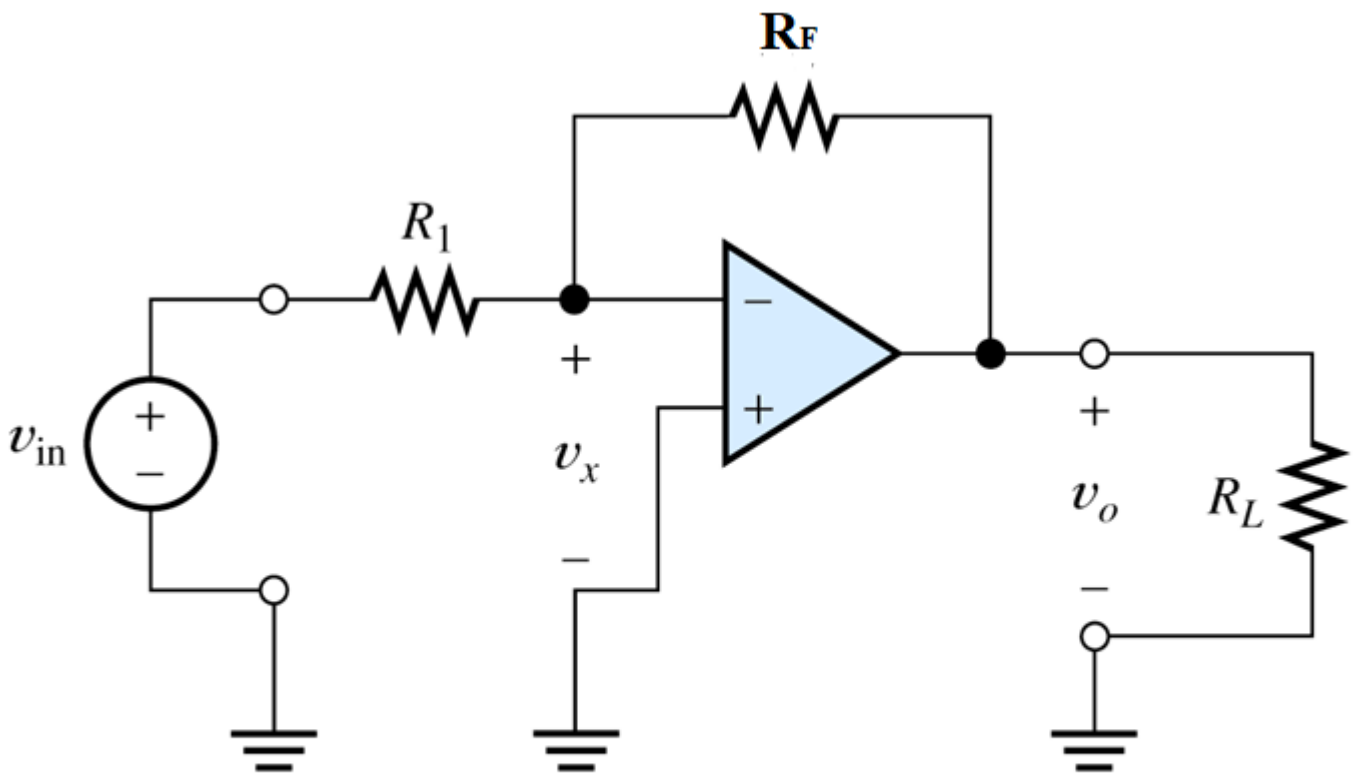
OPERATIONAL AMPLIFIER (OP-AMP)

CLOSED-LOOP CONFIGURATIONS

- Open-loop voltage gain of OPAMP is very high; such high gain is not required in most applications
- In order to reduce gain, a part of output signal is fed back to the inverting input terminal (called negative feedback)
- Many other OPAMP characteristics are improvised with this

INVERTING AMPLIFIER

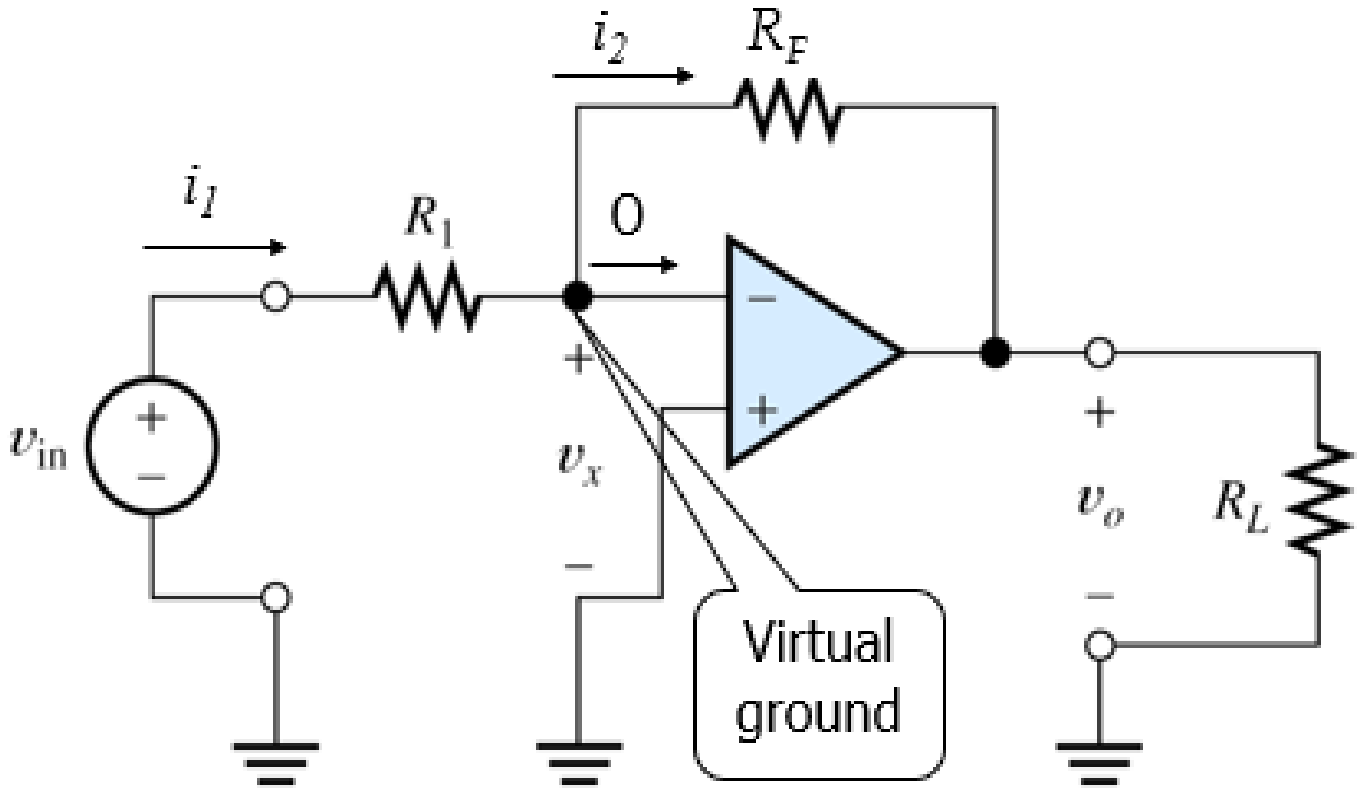


INVERTING AMPLIFIER

- Input is applied to inverting terminal
- Non-inverting is grounded
- Feedback is given to inverting terminal through resistor R_F
- Assuming v_o is less than V_{CC}

  since A_d is very high, v_{id} should be very small; v_{id} taken as almost zero
- Current entering OPAMP input terminal is almost zero

INVERTING AMPLIFIER



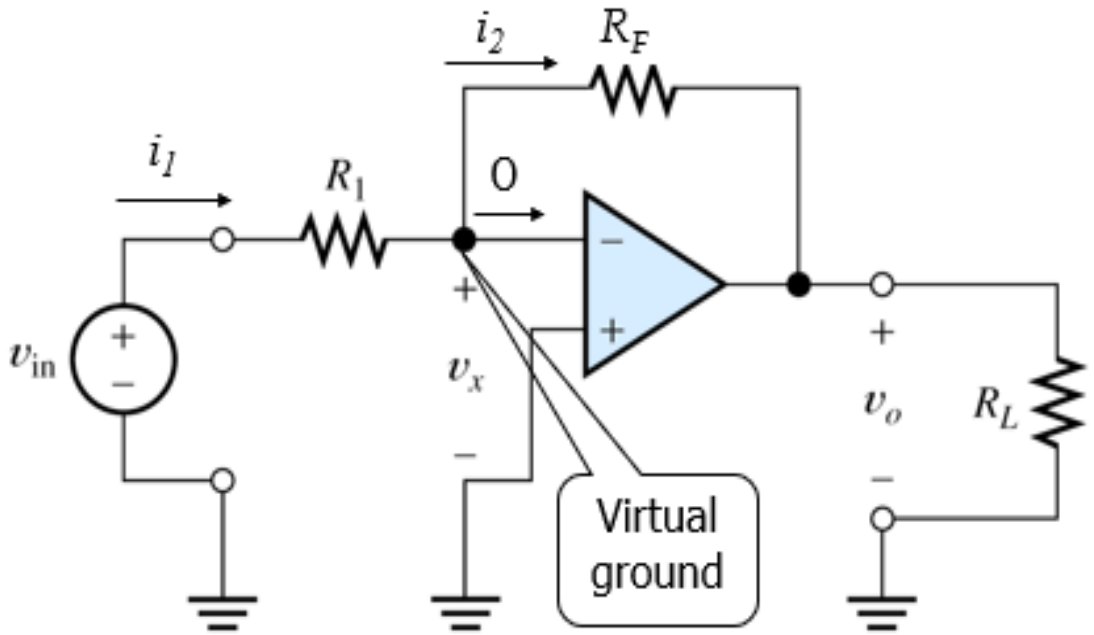
INVERTING AMPLIFIER

$$i_1 = \frac{v_{in} - 0}{R_1} = \frac{v_{in}}{R_1}$$

$$i_2 = \frac{0 - v_o}{R_F} = \frac{-v_o}{R_F}$$

$$i_1 = i_2$$

$$\frac{v_{in}}{R_1} = \frac{-v_o}{R_F}$$



$$v_o = -v_{in}\frac{R_F}{R_1}$$

$$A_V = \frac{v_o}{v_{in}} = -\frac{R_F}{R_1}$$

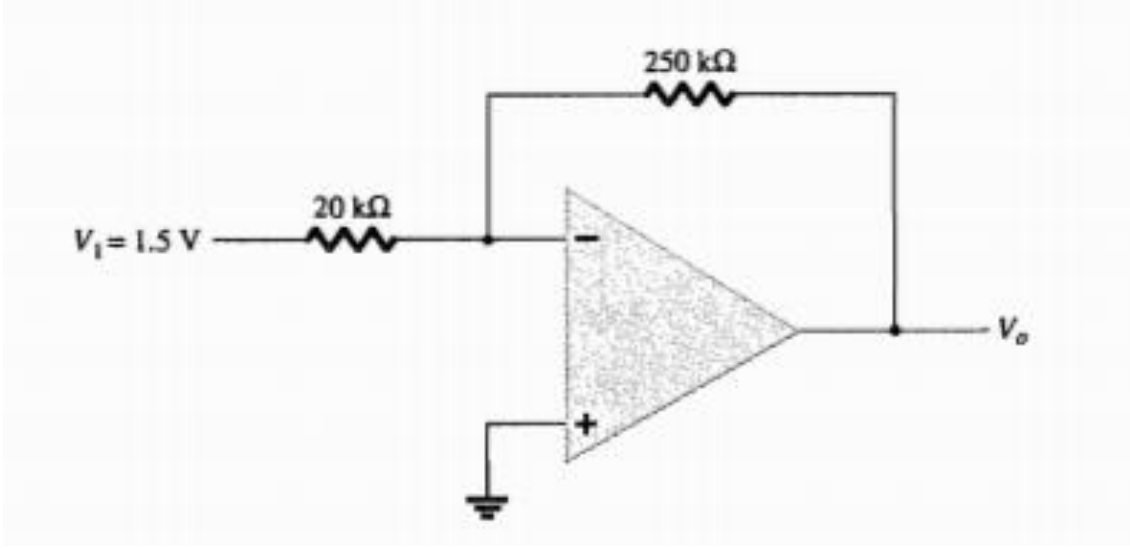
PROBLEMS

1. For an inverting amplifier using OPAMP, R_1=1K, R_F=100K, v_{in}=0.1sin(ωt). Find v_o.
2. For an inverting amplifier, R_1=10K, R_F=100K. Calculate v_o if v_i = 25 mV dc.

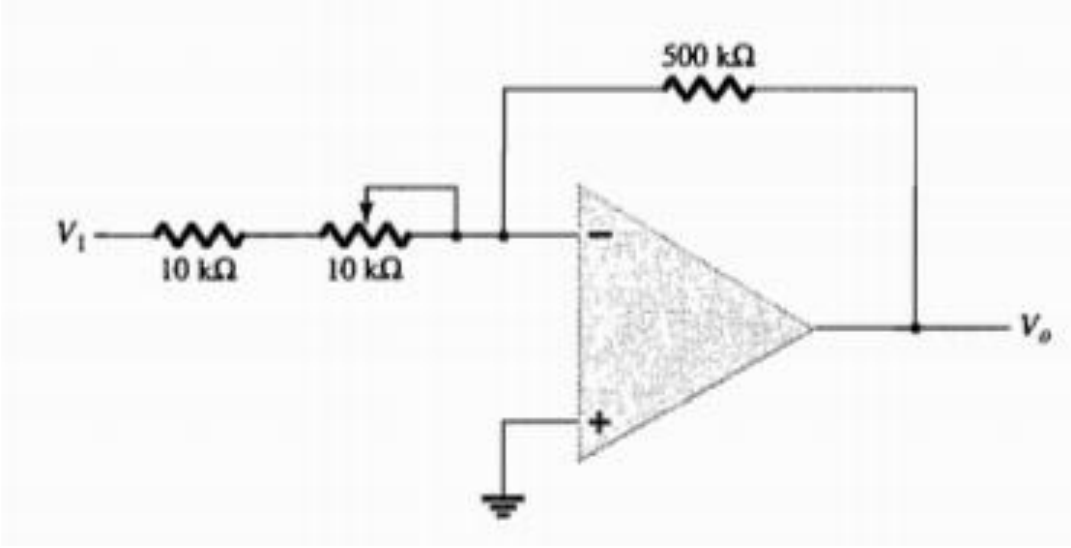
3. An ac signal of rms value 2 mV needs to be amplified to 1.024 V rms, 180 degree phase shifted. Design a suitable amplifier choosing R_1=1.2K
4. Design an amplifier to get an output amplified by 25 times of the input signal .

EXAMPLE 5

Find the output voltage Vo for the following circuit, where Vin is the input voltage .

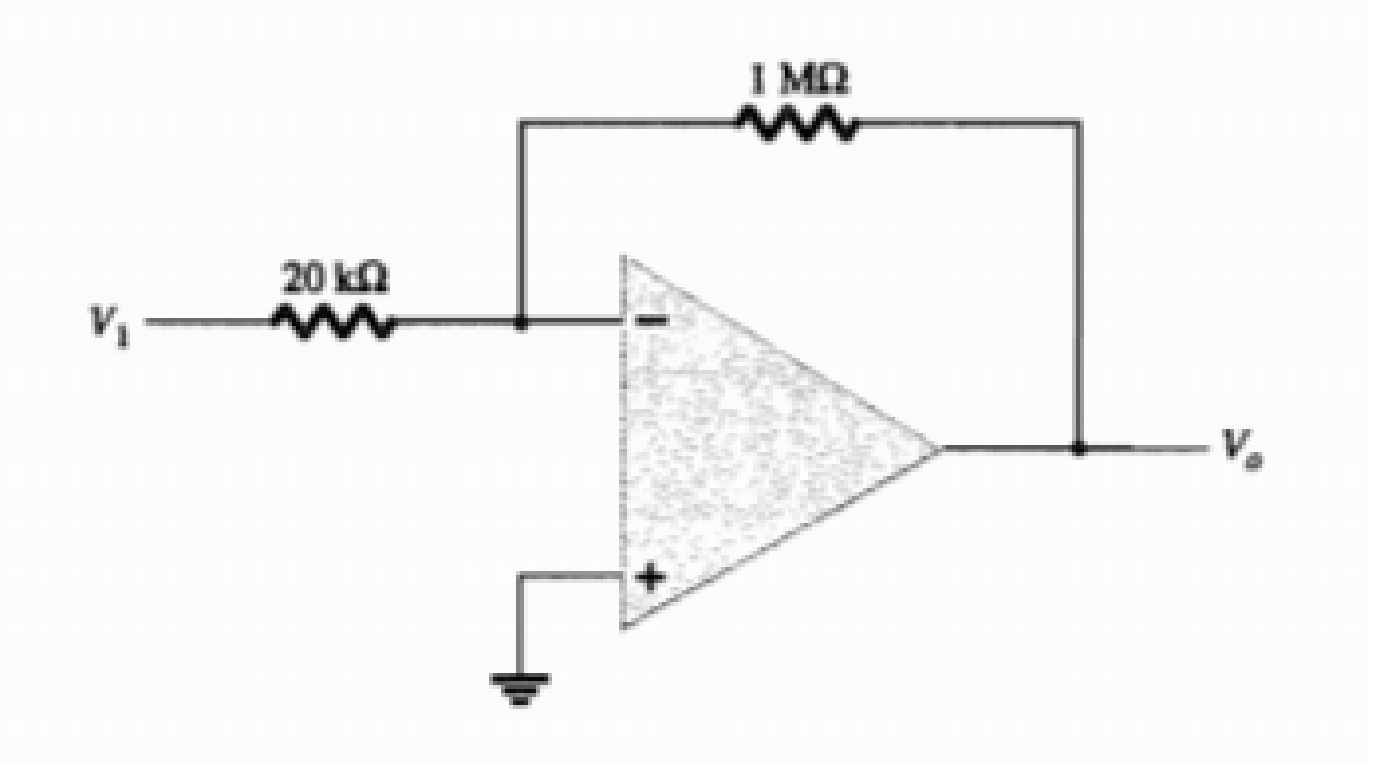


Find the range of output voltage gain adjustment for the following circuit, where Vi is the input voltage .



EXAMPLE 6

What input voltage will result if an output voltage Vo =2V for the following circuit, where Vi is the input voltage .



EXAMPLE 7:

Calculate the output voltage Vo for the following circuit, where Vi is the input voltage

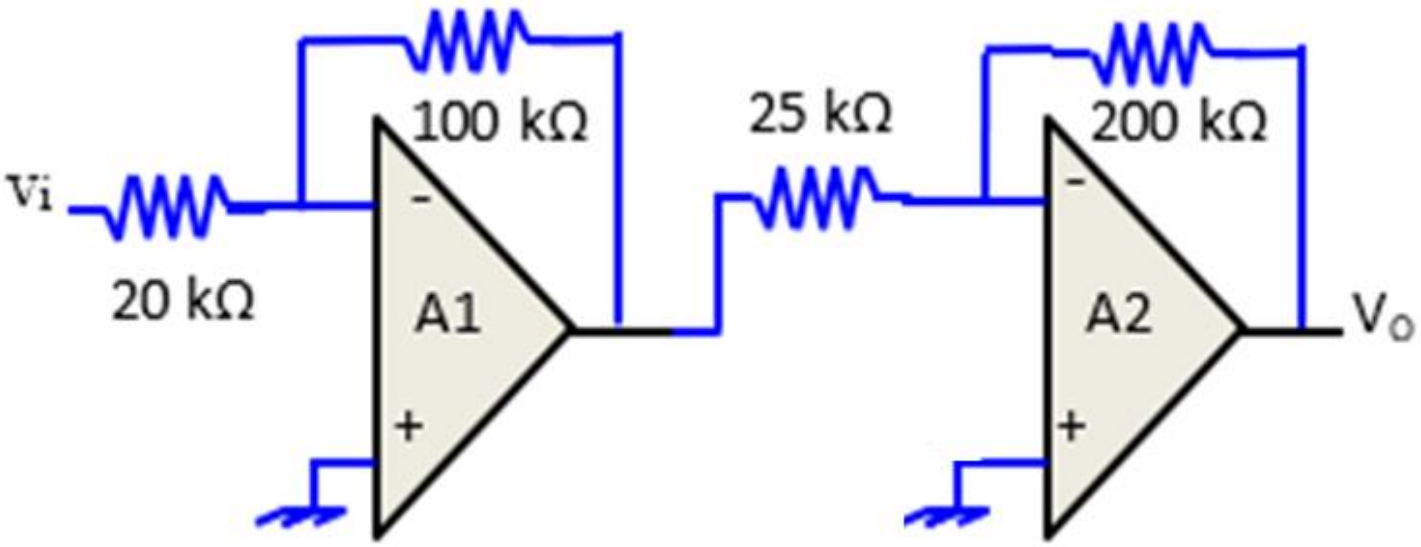
Solution :

The output of Op-Amp A1 is (say)

$$v_{o1} = -\frac{100}{20} v_i = -5v_i$$

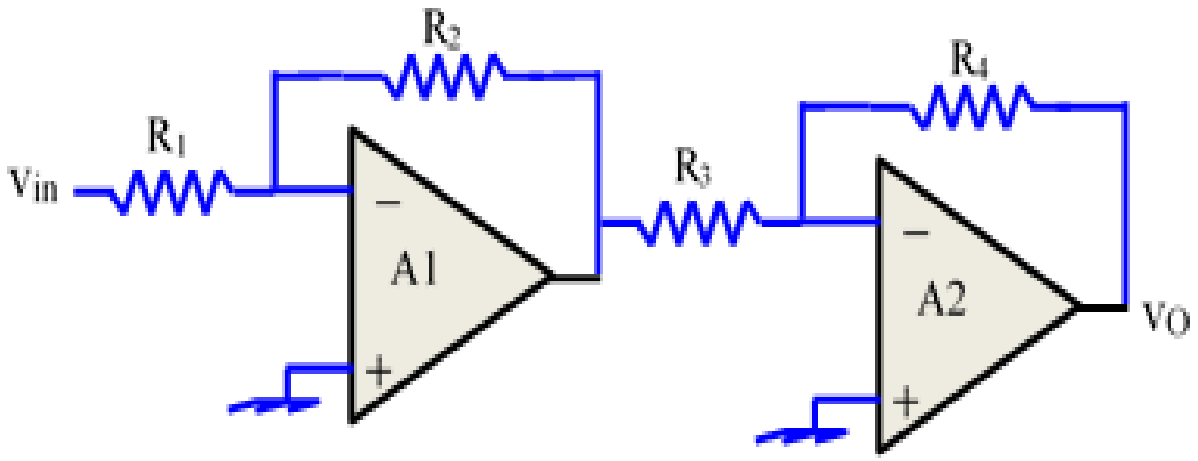
The output of Op-Amp A2 is

$$= -\frac{200}{25} v_{o1}$$
$$= -8(-5v_i)$$
$$= 40v_i)$$



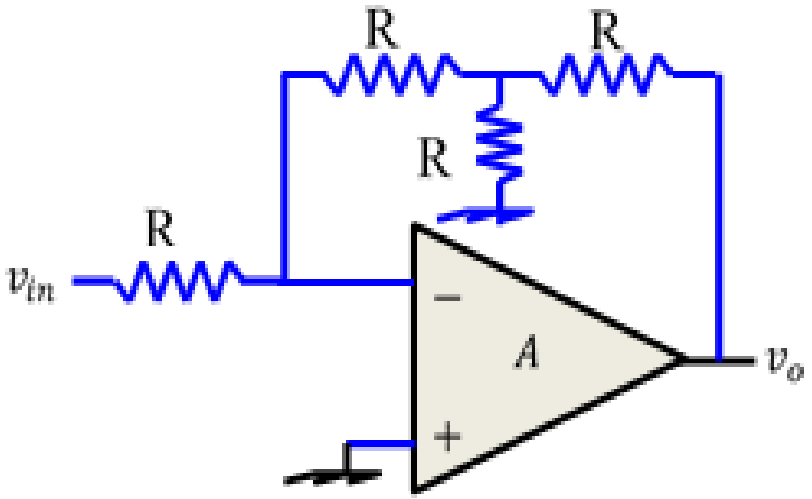
EXAMPLE 8

Find an expression for the output voltage Vo for the following circuit, where Vin is the input voltage .



EXAMPLE 9

Find the expression for output voltage V_o of the following circuit.



Soln.
Apply KCL.

Thank you