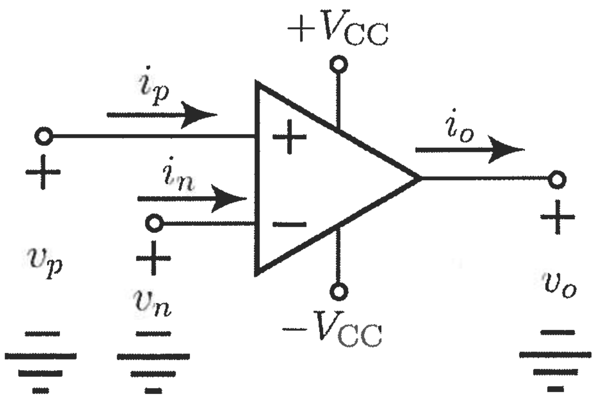
Week 2 Quiz Solutions

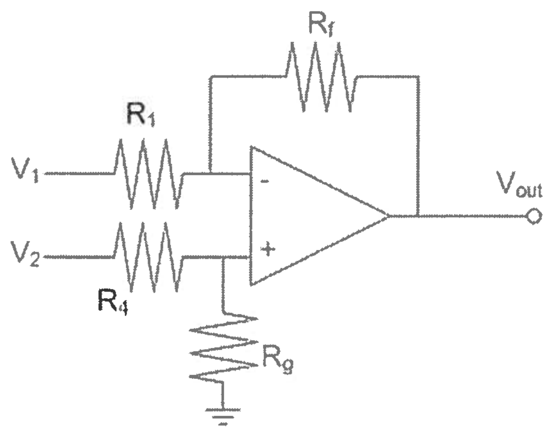
1.



For the ideal operational amplifier circuit above, which of the following are true?

- [x] $i_p = i_n$
- [x] $i_n = 0$
- [ ] $v_p / i_p = 0$
- [x] $v_o \leq V_{CC}$

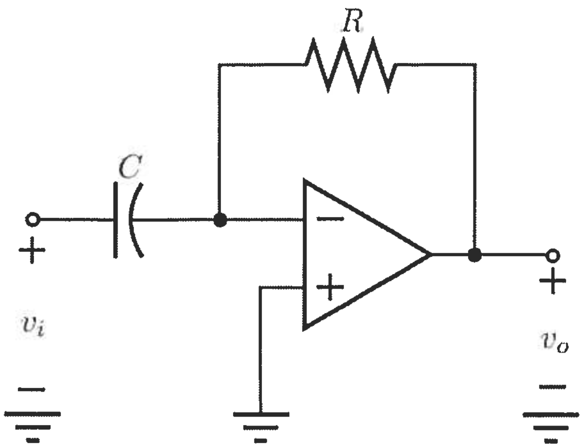
2.



For the difference amplifier circuit above, if R_1=R_4=1000Ω and R_f=R_g=2000Ω, what is the gain, G, of the circuit where v_o=G(v_2−v_1)?

$$G = \frac{R_f}{R_1} = \frac{2000}{1000} = 2$$

3.



Consider the inverting differentiator shown above. If R=2000Ω and C=0.25μF, and Vi(t)=e −2000tV what is the accurate expression for Vo(t)?

- Vout(t)=2000e(−2000t)V
- Vout(t)=.005e(−2000t)V
- Vout(t)=e(−2000t)V
- Vout(t)=-2000e(−2000t)V

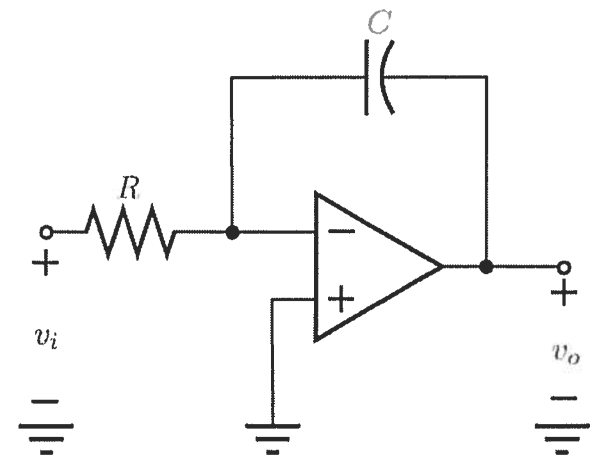
$$V_o = -RC\frac{dV_{iN}}{dt}$$

$$= -(2000 \quad 0.25\times10^{-6})\frac{dV_{iN}}{dt}$$

$$= -0.5\times10^{-3}(-2000)e^{-2000t}$$

$$= e^{-2000t} \checkmark$$

4. The input to the following op amp circuit is vi(t)=10cos(100t). If R=10kΩ and C=2μF, determine the value of vo in volts and select the most appropriate answer below.



- vo(t)=50cos(100t).
- vo(t)=-10cos(100t).
- vo(t)=5cos(100t+90).
- vo(t)=5cos(100t).
- vo(t)=5cos(100t-90).

$$V_o = \frac{-1}{RC}\int_0^t V_{in}\,dt$$

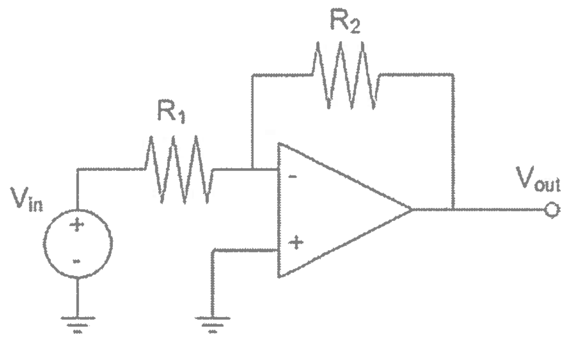
$$= \frac{-1}{2\times10^{-2}} \frac{10}{100} \sin(100t)$$

$$= -5 \sin 100t$$

$$\sin X = \cos(X - 90^\circ) = -\cos(X + 90^\circ)$$

$$-5\sin(100t) = 5\cos(100t + 90^\circ)$$

5.

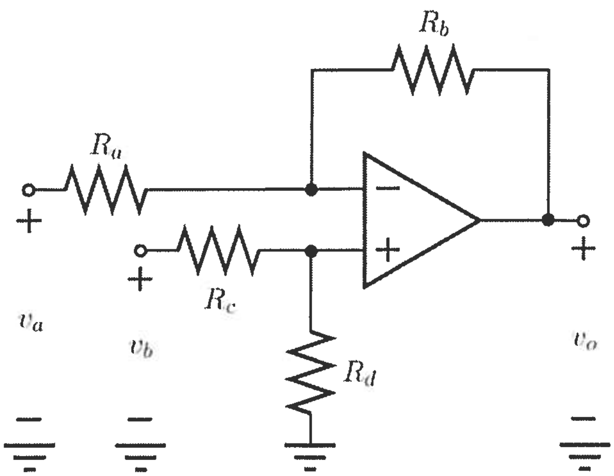


For the inverting operational amplifier circuit above, if R2=10kΩ and the closed-loop gain is G= −5000, what is the appropriate resistance for R1? Submit your answer in units of Ohms, while omitting the unit. For example, if your answer is 1000Ω submit 1000.

$$G = \frac{-R_2}{R_1} \Rightarrow -5000 = \frac{-10000}{R_1}$$

$$R_1 = \frac{10000}{5000} = 2\,\Omega$$

6.

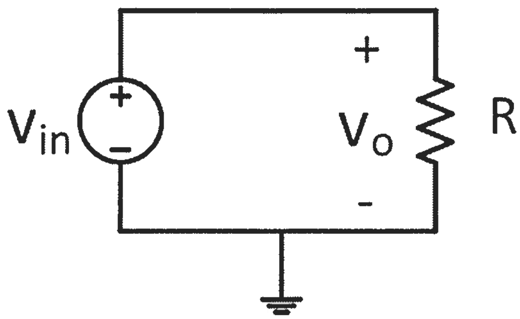


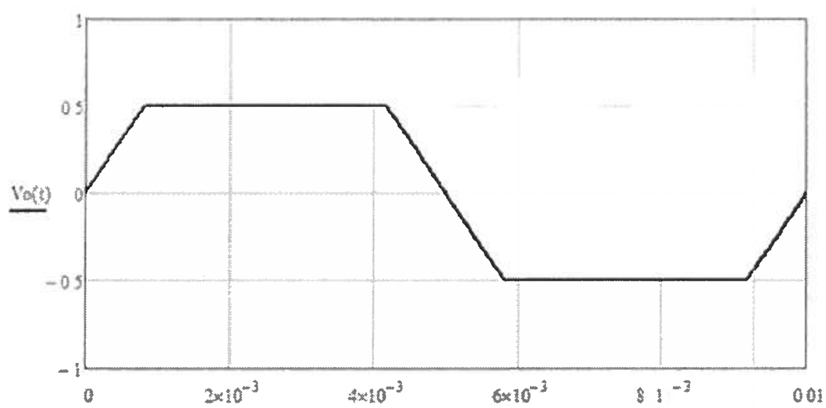
For this question, Ra=3kΩ, Rb=12kΩ, Rc=3kΩ, and Rd=12kΩ. va=6V and vb=14V. What is vo? Give your answer in Volts and omit the units from your answer.

$$v_o = \frac{R_b}{R_a}(v_b - v_a) = \frac{12}{3}(14-6)$$

$$= 4(8) = 32\,V$$

7. For the circuit shown, Vin=Vin(t) = sin(ωt) and R=100Ω. A plot of the output voltage VO(t) is shown. What is the maximum current in <u>milliamps</u> that can be supplied by the voltage source?



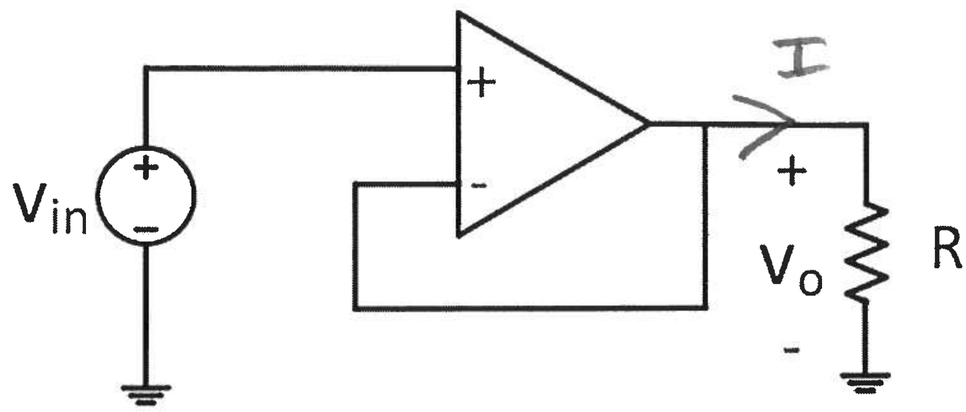


Maximum current $= \dfrac{\text{Max Voltage}}{R}$

$= \dfrac{0.5\text{ V (from plot)}}{100} = .005\text{ A}$

$= 5\text{ mA}$

8. An opamp is used as a buffer between the source and the load resistor R in the circuit of <u>question 7</u> as shown. What minimum current in <u>milliamps</u> must the op-amp be able to supply so that $V_O(t) = V_{in}(t)$?

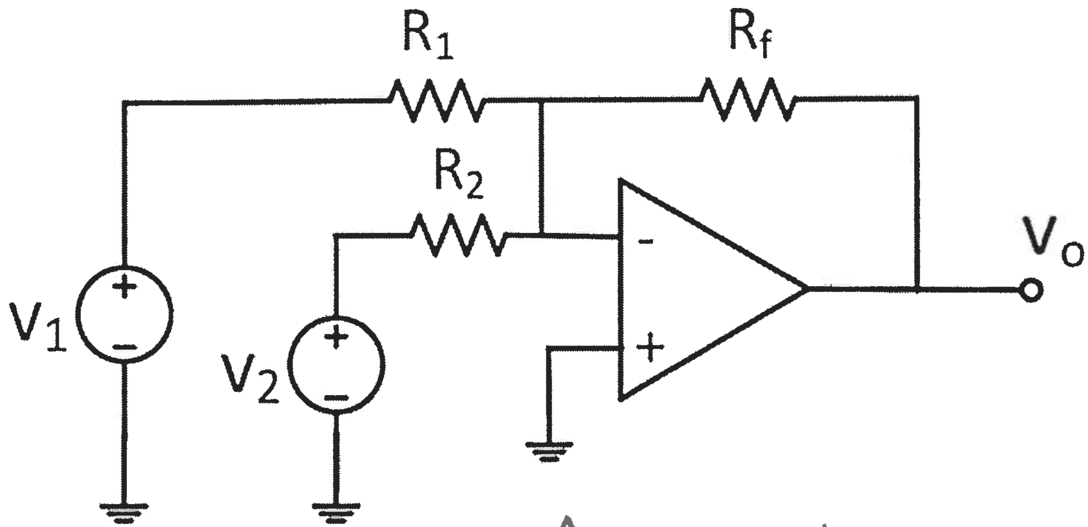


I is a maximum when V_{IN} is a max of 1V.

$$I = \frac{1V}{100\Omega} = 10mA.$$

The op amp must be able to supply at least this current or the output will be clipped for the 1V amplitude sine wave input.

9. For the circuit shown, $V_1 = 3V$, $V_2 = -2V$, $R_1 = 2k\Omega$, $R_f = 10k\Omega$, and the output voltage $V_O = -7V$. What is the value of the resistor R_2 in $k\Omega$?



Inverting summer

$$V_o = -\frac{R_F}{R_1} V_1 + -\frac{R_F}{R_2} V_2$$

$$-7 = \frac{-10}{2} 3 + \frac{-10}{R_2}(-2)$$

$$8 = \frac{20}{R_2} \Rightarrow R_2 = \frac{20}{8} = 2.5 k\Omega$$