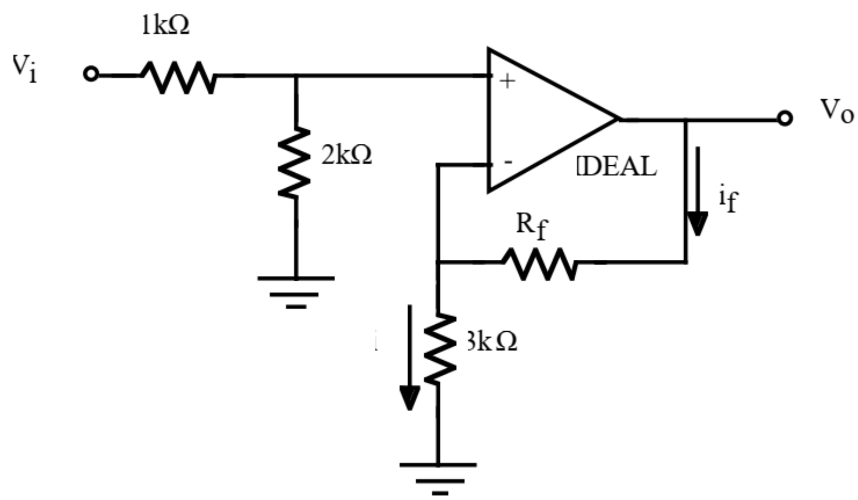
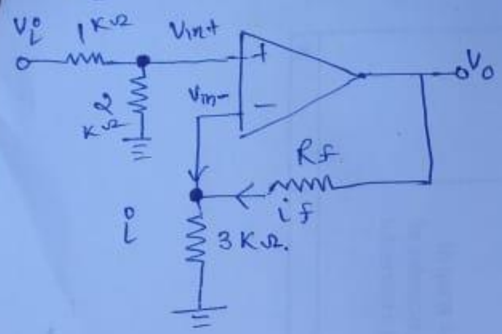
Q1. For the ideal op amp shown, what should be the value of resistor R_f to obtain a gain of 5?



Answer : 19.5 kΩ

Sol 1.



Find V_{in+}

Apply voltage divider rule

$$V_{in+} = \frac{2}{2+1} \times V_i = \frac{2}{3} V_i$$

Now using virtual concept

$$V_{in+} = V_{in-} = \frac{2}{3} V_i$$

Now Consider a feedback loop

$$i = i_f$$

$$\frac{V_{in-} - 0}{3} = \frac{V_o - V_{in-}}{R_f}$$

$$\frac{\frac{2}{3} V_i}{3} = \frac{V_o - \frac{2}{3} V_i}{R_f}$$

But $V_o = 5 V_i$

$$\frac{2}{9} V_i = \frac{5 V_i - \frac{2}{3} V_i}{R_f}$$

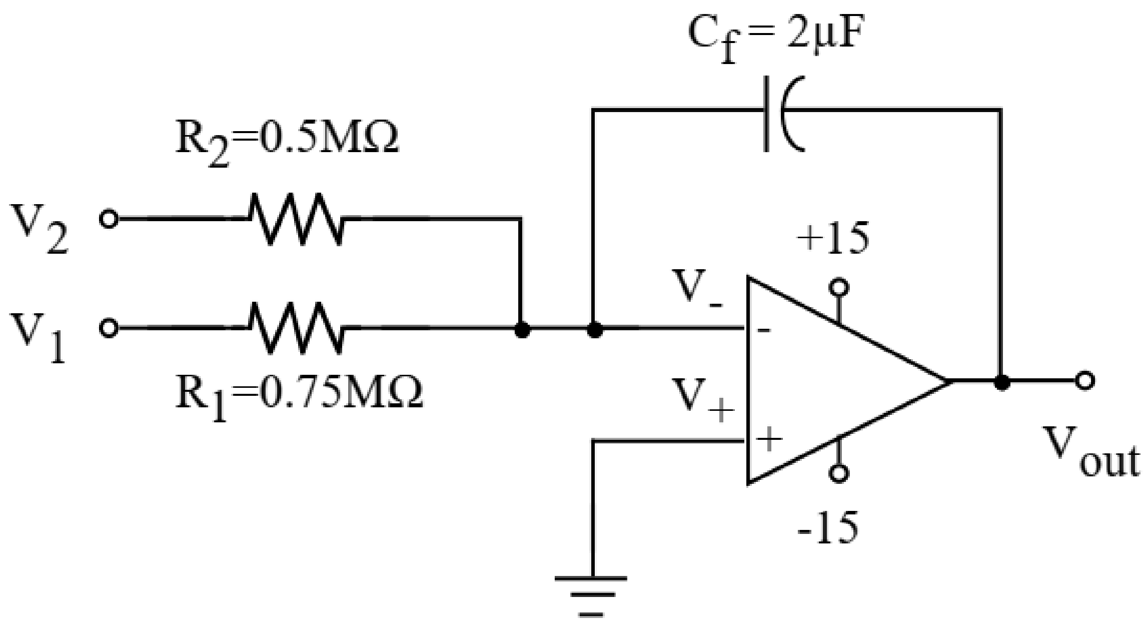
$$\frac{2}{9} V_i = \frac{15 V_i - 2 V_i}{3 R_f}$$

$$\frac{2}{9} V_i = \frac{13 V_i}{3 R_f}$$

$$R_f = \frac{13 \times 9^3}{2 \times 3}$$

$$= \frac{39}{2} = 19.5\ K\Omega$$

Q2. For the circuit shown below, $V_1 = 10\sin(200t)$ and $V_2 = 15\sin(200t)$. What is V_{out}? The op amp is ideal with infinite gain.



Answer : (3/40 + 1/ 30) cos (200t)

Sol 2

Apply KCL at inverting point.

$$\frac{V_2 - 0}{R_2} + \frac{V_1 - 0}{R_1} = \frac{0 - V_{out}}{1/jwC}$$

$$\frac{V_2}{R_2} + \frac{V_1}{R_1} + jwC\,V_{out} = 0$$

$$V_{out} = -\frac{V_2}{R_2 jwC} - \frac{V_1}{jwCR_1}$$

$$\sin(200t) = \cos(200t - 90^\circ) \rightarrow 1\angle -90^\circ$$
$$= -j$$

$$V_{out} = \frac{-j15}{j(200)(2\times10^{-6})(0.5\times10^{6})} - \frac{(-j10)}{j(200)(2\times10^{-6})(0.75\times10^{6})}$$

$$= \frac{3}{40} + \frac{1}{30}$$

$$V_{out} = \left(\frac{3}{40} + \frac{1}{30}\right)\cos(200t)$$

$\frac{1}{3}$

$\frac{1}{2}$

Q3. Find the cut off frequency for low pass active filter for given specifications:
Resistor(R) = 1kohm and capacitor (C) = 1μF. **Answer : 159Hz**

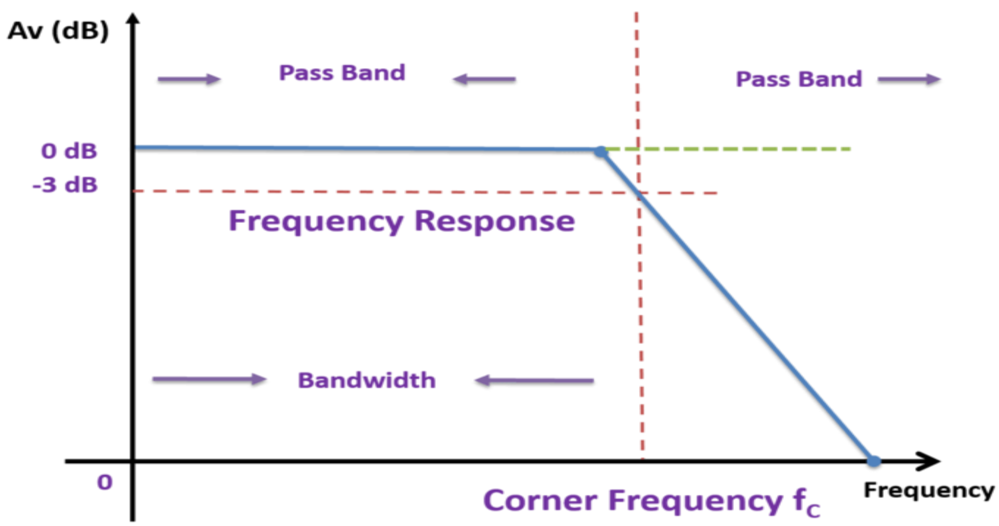
Solution

$$fc = \frac{1}{2\pi RC}\ Hz$$

Q4. The maximum gain of the low pass filter is 100dB. Find the gain at the critical frequency. **Answer : 97 dB**

Solution 3 db gain at fc

So 100-3=97 db



Q5. Design a non inverting amplifier that has a voltage gain of 10 using an ideal op amp. The input signal lie in the range from -1 V to 1 V. Use 5 % tolerance discrete resistors for the feedback network.

Answer : The values of resistances are restricted in the range 100Ω.. 1MΩ.

$A_{CL} = 1 + (R_f / R_2)$=Vout/Vin=10=1+Rf/2