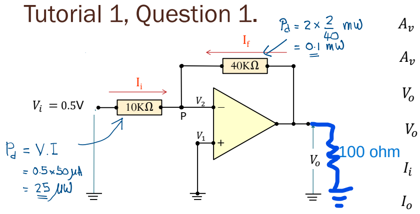
Tutorial 1, Question 1.



$P_d = 2 \times \frac{2}{40}$ mW $= 0.1$ mW

$A_v = -\left(\frac{R_f}{R}\right)$

$A_v = -\left(\frac{40}{10}\right) = -4$

$V_o = A_v V_i$

$V_o = -4(0.5) = -2$ V

$I_i = \frac{0.5}{10} mA = 50\ \mu A$

$I_o = \frac{-2}{100} A = -20$ mA

Calculate the following;
1) Output Voltage
2) Current drawn from the input
3) Current delivered to a 100Ω load
4) Overall power gain

$P_o = |V_o I_o| = 2V x 20mA = 40\ mW$

$P_i = |V_i I_i| = 0.5V x 50\mu A = 25\ \mu W$

$G = \frac{P_o}{P_i} = \frac{40{,}000}{25} = 1600$

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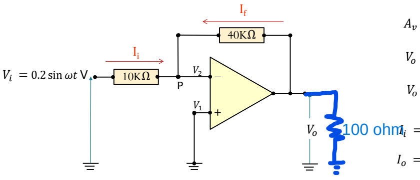
Tutorial 1, Question 2.



$A_v = -\left(\frac{R_f}{R}\right)$

$A_v = -\left(\frac{40}{10}\right) = -4$

$V_o = A_v V_i$

$V_o = -0.8 \sin \omega t\ V$

$I_i = \frac{0.2 \sin \omega t}{10} mA = 20 \sin \omega t\ \mu A$

$I_o = \frac{-0.8 \sin \omega t}{100} A = -8 \sin \omega t\ mA$

Calculate the following;
1) Output Voltage
2) Current drawn from the input
3) Current delivered to a 100Ω load
4) Output power
5) Input power
6) Power Gain

$P_o = \frac{1}{2}|V_{o,pk} I_{o,pk}| = \frac{1}{2} 0.8V x 8mA = 3.2\ mW$

$P_i = \frac{1}{2}|V_{i,pk} I_{i,pk}| = \frac{1}{2} 0.2V x 20\mu A = 2\ \mu W$

$G = \frac{P_o}{P_i} = \frac{3200}{2} = 1600$

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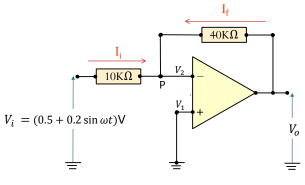
Tutorial 1, Question 3.



$A_v = -\left(\frac{40}{10}\right) = -4$

$V_o = A_v V_i$

$V_o = -4(0.5 + 0.2 \sin \omega t)$

$V_o = -(2 + 0.8 \sin \omega t)\ V$

$I_i = (50 + 20 \sin \omega t) mA$ uA

$I_o = -(20 + 8 \sin \omega t)\ mA$

Calculate the following;
1) Voltage at the output
2) Current drawn from the input
3) Current delivered from this amplifier to a 100Ω load
4) AC power and DC Power delivered to the load
5) Overall power gain

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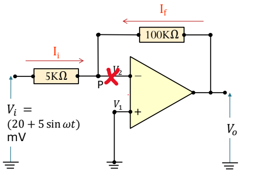
Tutorial 1, Question 4.



$I_i = (4 + \sin \omega t)\mu A$

$I_f = -(4 + \sin \omega t)\mu A$

$\boxed{A_v = -\left(\frac{R_f}{R}\right)}$

$A_v = -\left(\frac{100}{5}\right)$

$A_v = -20$

$V_o = A_v V_i$

$V_o = -20(20 + 5 \sin \omega t)$

$V_o = -(400 + 100 \sin \omega t)\ mV$

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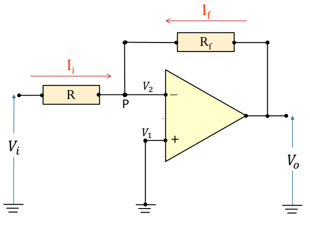
4) Non-Inverting Amplifier



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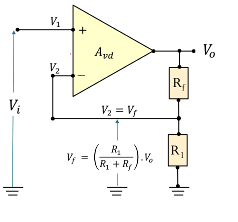
Non-Inverting Amplifier



$V_o = A_{vd}.(V_1 - V_2)$

$V_o = A_{vd}.(V_i - V_f)$

$\frac{V_o}{A_{vd}} = (V_i - V_f)$

$(V_i - V_f) = 0$

$V_i = V_f$

$V_i = \left(\frac{R_1}{R_1 + R_2}\right).V_o$

$A_v = \frac{V_o}{V_i} = \left(\frac{R_1 + R_f}{R_1}\right)$

$A_v = \left(1 + \frac{R_f}{R_1}\right)$

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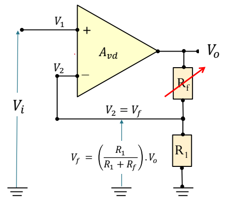
Non-Inverting Amplifier



$$\boxed{A_v = \left(1 + \frac{R_f}{R_1}\right)}$$

- Opamp provides the virtual short circuit and current drive
- Vol. gain totally depend on the two resistors.
- Amplify ac and dc components of input signal by same gain.
- No phase change
- Voltage gain always > 1

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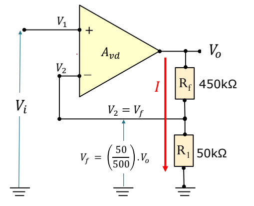
Tutorial 1, Question 5.



$V_i = (100 + 20\sin\omega t)$ mV

$I = \left(\frac{V_o}{500}\right) = 2 + 0.4\ \sin\omega t$ μA

$$\boxed{A_v = \left(1 + \frac{R_f}{R_1}\right)}$$

$$A_v = \left(1 + \frac{450}{50}\right)$$

$$A_v = 10$$

$$V_o = A_v V_i$$

$$V_o = 10(100 + 20\sin\omega t)\ mV$$

$$V_o = (1000 + 200\sin\omega t)\ mV$$

$$V_o = 1 + 0.2\sin\omega t\ \ V$$

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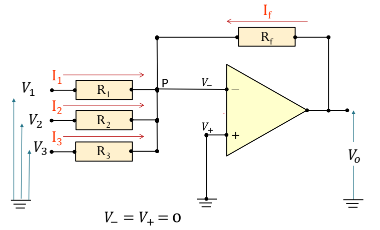
5) Scaling Adder



$V_- = V_+ = 0$

$V_P = 0$

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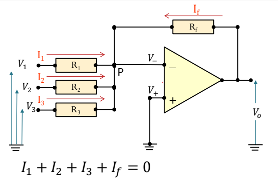
Scaling Adder



$$I_1 + I_2 + I_3 + I_f = 0$$

$$\left(\frac{V_1 - V_P}{R_1}\right) + \left(\frac{V_2 - V_P}{R_2}\right) + \left(\frac{V_3 - V_P}{R_3}\right) + \left(\frac{V_o - V_P}{R_f}\right) = 0$$

$$\left(\frac{V_1 - 0}{R_1}\right) + \left(\frac{V_2 - 0}{R_2}\right) + \left(\frac{V_3 - 0}{R_3}\right) + \left(\frac{V_o - 0}{R_f}\right) = 0$$

$$\left(\frac{V_1}{R_1}\right) + \left(\frac{V_2}{R_2}\right) + \left(\frac{V_3}{R_3}\right) + \left(\frac{V_o}{R_f}\right) = 0$$

$$V_o = -R_f.\left[\left(\frac{V_1}{R_1}\right) + \left(\frac{V_2}{R_2}\right) + \left(\frac{V_3}{R_3}\right)\right]$$

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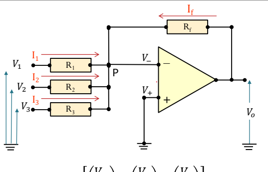
Scaling Adder



$$V_o = -R_f.\left[\left(\frac{V_1}{R_1}\right) + \left(\frac{V_2}{R_2}\right) + \left(\frac{V_3}{R_3}\right)\right]$$

$$V_o = \left[\left(\frac{R_f}{R_1}\right).V_1 + \left(\frac{R_f}{R_2}\right).V_2 + \left(\frac{R_f}{R_3}\right).V_3\right]$$

$$V_o = K_1.V_1 + K_2.V_2 + K_3.V_3$$

K_1, K_2, K_3 are scaling factors applied to respective inputs

If R_1=R_2=R_3=R; $V_o = \frac{R_f}{R}(V_1 + .V_2 + V_3)$

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