EE230 : Analog Circuits Lab

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Experiment 6 : Opamp Amplifiers

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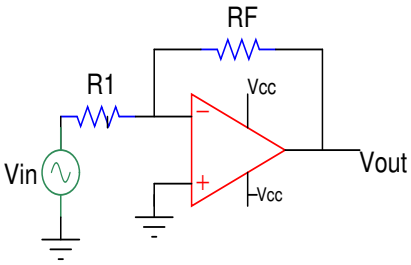
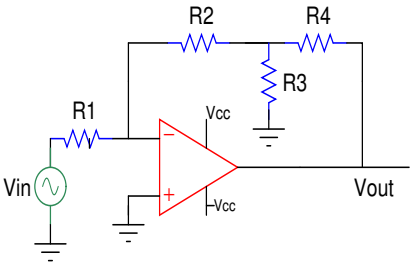
Inverting Amplifier



$$\frac{V_{Out}}{V_{In}} = \frac{-R_F}{R_1}$$

Answers :
1) Unique features of Inverting Amplifier :
a) No current flows into the input terminal **b)** There is a virtual short between both terminals of Opamp **c)** Very stable system due to negative feedback
2) Limitations of Inverting Amplifier :
a) Finite input resistance (R_{In}) **b)** We compromise gain for accuracy **c)** The applied input signal should not contain the noise because small value applied will be multiplied and obtained at the output **d)** Clipping beyond +Vcc and -Vcc
3) Applications of Inverting Amplifier :
a) Used in oscillator circuits due to phase inverting capabilities **b)** It can be practically used in the applications of the integration

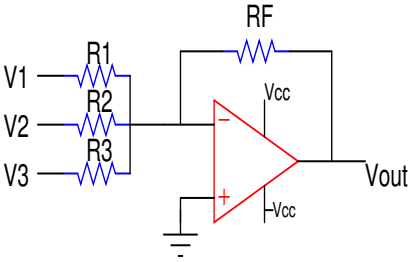
A Special Inverting Amplifier (with Higher Input Resistance and Voltage Gain)



$$\frac{V_{Out}}{V_{In}} = \frac{-R_F}{R_1}(1 + \frac{R_4}{R_2} + \frac{R_4}{R_3})$$

Answers : 1) Advantages :
a) Circuit utilises lesser resistances to give higher gain as compared to normal Inverting Amplifier. Hence, usage of high inverting resistance is avoided. **b)** Circuit can also be used as Current Amplifier

The Weighted Summer



$$V_{Out} = -R_F(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3})$$

The weighted summer is very useful in combining different signals. It is used in audio mixer.
`I learned the structure, uses, advantages and disadvantages of Inverting Amplifier`

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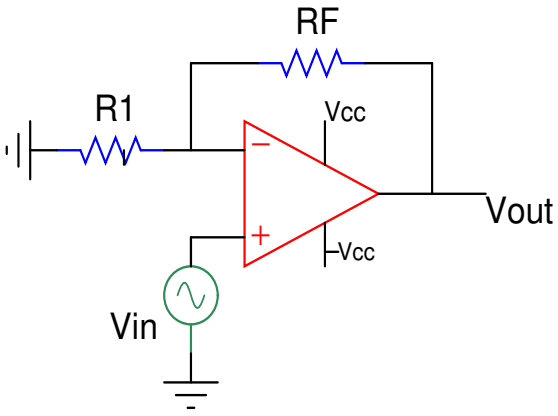
Non-inverting Amplifier



Circuit diagram of the non-inverting voltage amplifier is shown in the figure above. This circuit is the most preferred one and commonly used in voltage amplifier circuits.

$$\frac{V_{Out}}{V_{In}} = 1 + \frac{R_F}{R_1}$$

This circuit is quite different from the inverting amplifier. For the same values of R1 and RF, the magnitude of the voltage gain is marginally higher compared to the inverting amplifier.

Answers :

1) Unique features of Non-inverting Amplifier :

a) The voltage gain is always greater than one

b) The voltage gain is positive, indicating that for AC input, the output is in-phase with the input signal and for DC input, the output polarity is the same as the input polarity.

c) The voltage gain of the non-inverting op-amp depends only on the resistor values and is independent of the open-loop gain of the op-amp.

d) Infinite Input Resistance R_{In} and zero Output Resistance R_{Out}

2) Applications of Non-inverting Amplifier :

Non-inverting Amplifier is used in Voltage Follower, Power Amplifier, Impedance Transformer, etc. because precise output characteristics.

3) Limitations of Non-inverting Amplifier :

a) The input signal range of the non-inverting amplifier is limited by the op amp's common-mode input voltage range

b) The amplifying circuit has no virtual ground, so it has a large common mode voltage, and the anti-interference ability is relatively poor. So that the Opamp requires a higher common mode rejection ratio

c) This amplifier can only amplify signals upto the range of +Vcc to -Vcc. Beyond this range, we may lose information **d)** Another disadvantage is that the amplification factor can only be greater than one.

`I learned the structure, uses, advantages and disadvantages of Non-inverting Amplifier`

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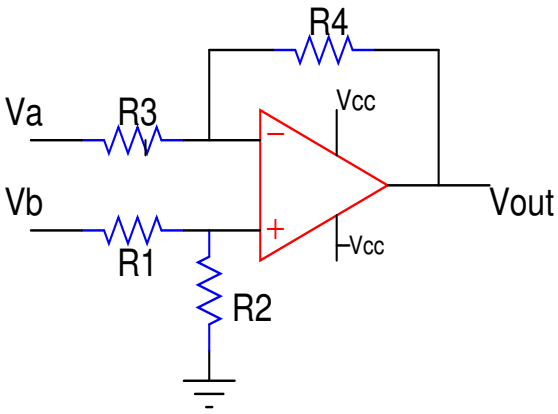
Difference Amplifier



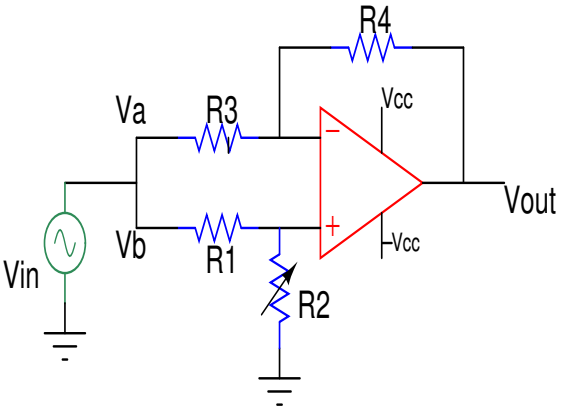
The third major single opamp amplifier configuration is the difference amplifier. In order for the circuit to work as a difference amplifier with a differential gain, Ad = R4/R3, the following condition has to be satisfied:

$$\frac{R4}{R3} = \frac{R2}{R1}$$

$$V_{Out} = (V_a - V_b)\frac{R_4}{R_3}$$

Difference Amplifier is used to amplify the small difference between the inputs

Measurement of Common-mode Gain Acm



A very important parameter of the difference amplifier is its common-mode gain, Acm.

Answers :

1) Unique features of Single-Opamp Difference Amplifier :

a) If all the resistors are all of the same ohmic value, that is: R1 = R2 = R3 = R4 then the circuit will become a Unity Gain Differential Amplifier and the voltage gain of the amplifier will be exactly one or unity. Then the output expression would simply be Vout = V2 – V1.

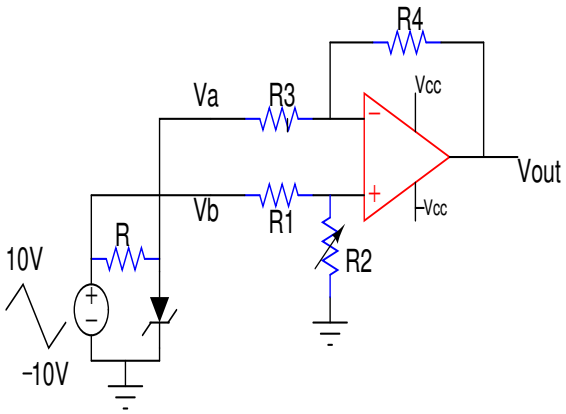
b) Single-Opamp Difference Amplifiers are used to design Instrumentation Amplifier which is more accurate version of it. Instrumentation amplifiers are mainly used to amplify very small differential signals from strain gauges, thermocouples or current sensing devices in motor control systems.

2) Limitations of Single-Opamp Difference Amplifier :

a) One major limitation of this type of amplifier design is that its input impedances are lower compared to that of other operational amplifier configurations

b) Each input voltage source has to drive current through an input resistance, which has less overall impedance than that of the op-amps input alone. This may be good for a low impedance source such as the bridge circuit, but not so good for a high impedance source.

I-V Characteristics of a Zener Diode



With the circuit values as given above, the difference amplifier output Vout = $(V_A - V_B) = I_D$R.
Since R = 1 k Ω, the magnitude of Vout (in volts) will be the same as ID (in mA). We shall use the DSO in the XY mode with the Zener diode voltage VD connected as X and Vout (=ID) connected as Y.

Answers :

1) Triangular ramp function is used, due to its linear nature. We can easily plot Vout vs Vin. The ramp function acts as an x-axis for better plotting Vout.
If we use Sine or square function, they are very non-linear in nature, so they would give a complex nature.
Also in Square Wave, since it's composed of frequencies present from 0 to ∞, the Op Amp would be limited by it's slew rate and would give a delayed output to us.

2) If we increase the frequency, the capacitor impedance in the Zener diode would become significant. It is because the frequency would become so high than the transit time.

3) Cut-in voltages are different for LED's and Si-Ge diode, because all of them are made up of different material, with different doping density, there's difference between the cut-in voltages.

`I learned the structure, uses, advantages and disadvantages of Difference Amplifier and it's applications`

References

1) Lecture Slides
2) Sedra-Smith
3) WEL Resources for NGSpice