Electronics II

Lecture 13
Operational Amplifiers- Applications

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The theme of this presentation is an inspiration from the one used in S2 Department of Chalmers University of Technology, Gothenburg, Sweden.

Previous Lecture

- Operational Amplifier Amplifier
  - Ideal Op-amp.
  - Modes of Operation.
  - Common Mode Rejection Ratio

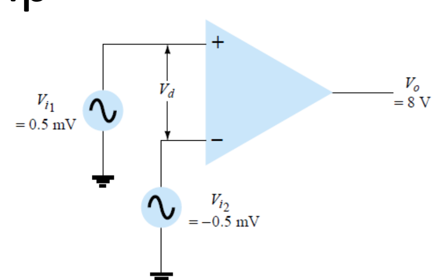
Session Overview

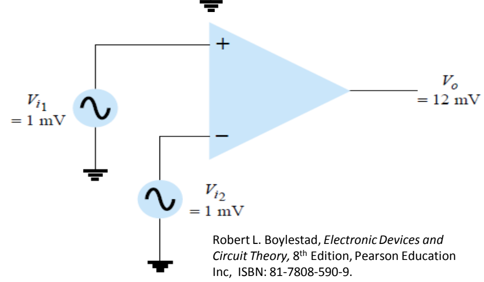
Topic	Operational Amplifiers (Op Amp)- Applications
Concepts	Voltage Summation, Voltage Subtraction.
Recommended Reading	Section 13.1, 13.2 & 13.4 of [1] Section 8-2 of [2].
Keywords	Op Amp, Single Ended, Double Ended, Common Mode, Summation, Subtraction.

Op Amp

- *Example 13.1 (Boylestad)*: Calculate CMRR for the given circuit.

  Solution:

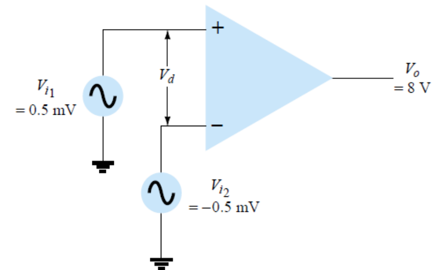


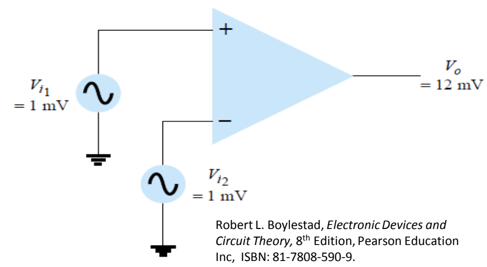


Robert L. Boylestad, *Electronic Devices and Circuit Theory*, 8th Edition, Pearson Education Inc, ISBN: 81-7808-590-9.

Op Amp

- *Example 13.2 (Boylestad)*: Determine the output voltage of an op- amp for input voltages of Vi1= 150μV, Vi2= 140μV. The amplifier has a differential gain of Ad= 4000 and the CMRR is
  - (a) 100
  - (b) 10^5





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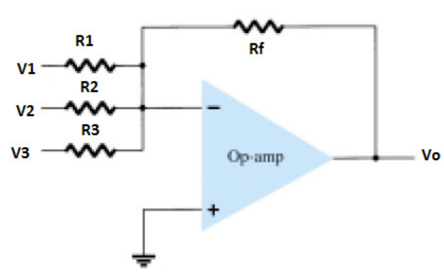
Voltage Summation (Op- Amp)

- A linear combination of different voltages using an op- amp is possible.
- An example of such summation could be 2v1+0.5v2+4v3.
- Such circuit is known as linear combination circuit.
- vo= - [(Rf/R1)*v1 + (Rf/R2)*v2+ (Rf/R3)*v3]

- For R1=R2=R3=R
  - vo=
- For Rf=R
  - vo



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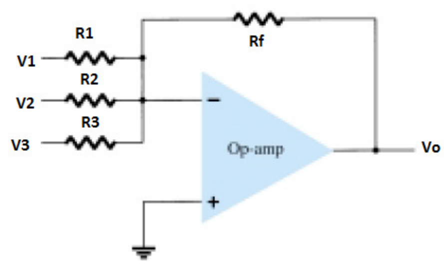
Voltage Summation (Op- Amp)

- Example 13.5 (Boylestad): Calculate the output voltage for the given values for Voltage summation
  - V1=+1V, V2=+2V, V3=+3V R1=500kΩ, R2= 1MΩ, R3=1MΩ
  - V1=-2V, V2=+3V, V3=+1V R1=200kΩ, R2= 500kΩ, R3=1MΩ
- For R1=R2=R3=R
  - vo=
- For Rf=R
  - Vo=



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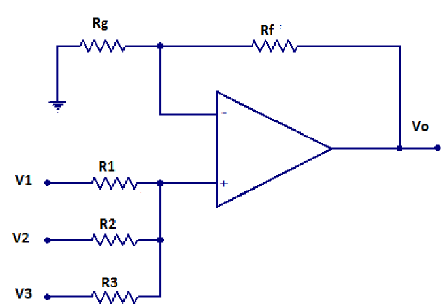
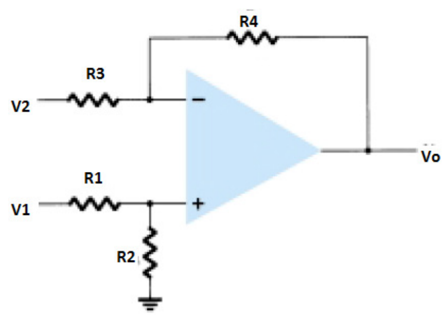
Voltage Summation (Op- Amp)

- Non Inverting configuration is also used.
- A bit more complex and cumbersome in terms of precision and calculations.
- Used in the applications where the phase inversion is necessarily not required.
- vo= (1+(Rf/RG))*((Rp/R1)v1 + (Rp/R2)v2 + (Rp/R3)v3)
  - Where Rp= R1||R2||R3



Voltage Subtraction (Op- Amp)

- An op- amp can be used in the differential mode in order to subtract the signals.
- The output voltage is calculated using the superposition
  - vo= vo1 + vo2
  - Where vo1= o/p because of v1.
  - vo2= o/p because of v2.
- This arrangement has some limited functionality to attain a scaled difference of the signals so another arrangement of op- amps is used for the voltage subtraction.



Theodore F. Bogart, Jeffery S. Beasley, Guilermo Rico, Electronics Devices and Circuits, 6th Edition, Pearson Education Inc, ISBN: 978-81-775-8887-3

References

[1] Robert L. Boylestad, *Electronic Devices and Circuit Theory,* 8th Edition, Pearson Education Inc, ISBN: 81-7808-590-9.

[2] Theodore F. Bogart, Jeffery S. Beasley, Guilermo Rico, Electronics Devices and Circuits, 6th Edition, Pearson Education Inc, ISBN: 978-81-775-8887-3