



Laboratorij za načrtovanje integriranih vezij



FE

UNIVERZA V LJUBLJANI
Fakulteta za elektrotehniko

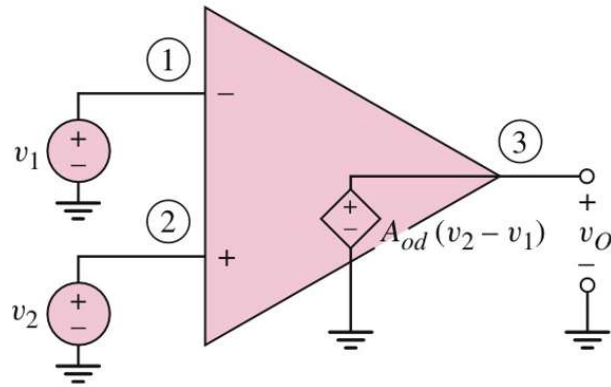
Linearna elektronska vezja

Operacijski ojačevalnik - idealni

In this chapter, we will:

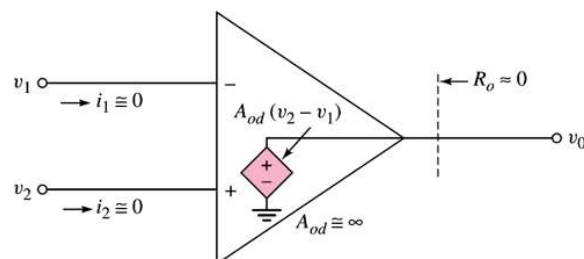
- ▶ Develop the parameters and characteristics of the ideal operational amplifier, and determine the analysis method of ideal op-amp circuits.
 - ▶ inverting operational amplifier
 - ▶ summing operational amplifier
 - ▶ noninverting operational amplifier
- ▶ Analyze several ideal op-amp circuits including the difference amplifier and the instrumentation amplifier.
- ▶ Design several ideal op-amp circuits with given design specifications.

Ideal Op-Amp Equivalent Circuit

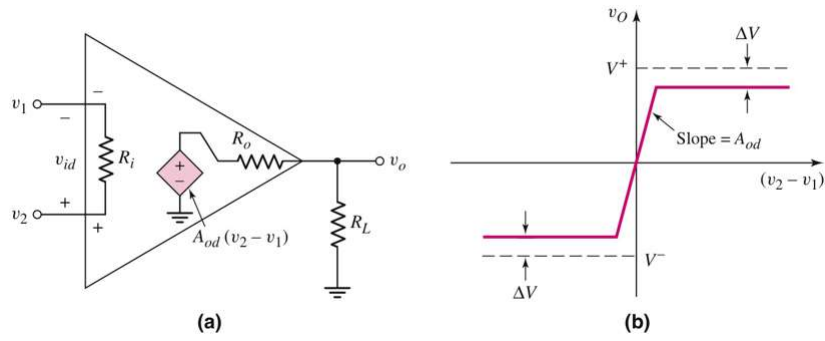


Ideal Op-Amp Characteristics

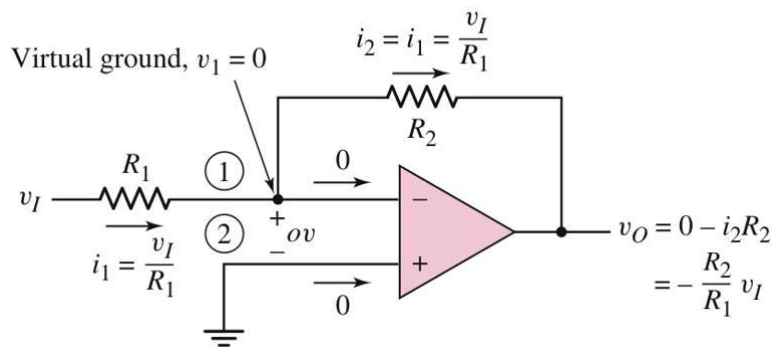
- ▶ Internal differential gain A_{od} is infinite.
- ▶ Differential input voltage ($v_2 - v_1$) is zero.
- ▶ Effective input resistance is infinite.
- ▶ Output resistance is zero, so output voltage is connected directly to dependent voltage source.



Equivalent Circuit of Op-Amp



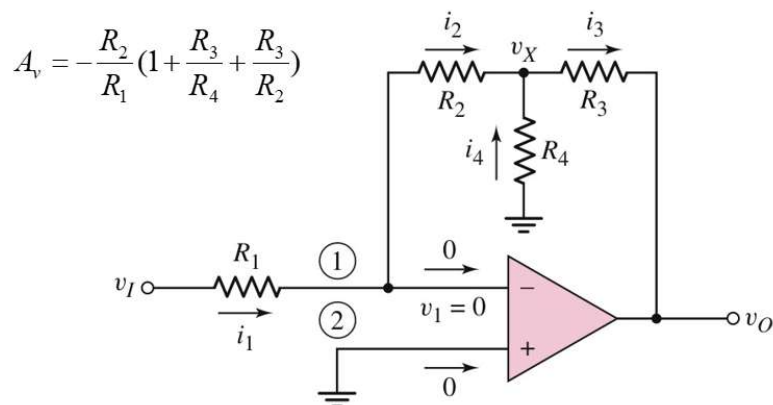
Inverting Op-Amp



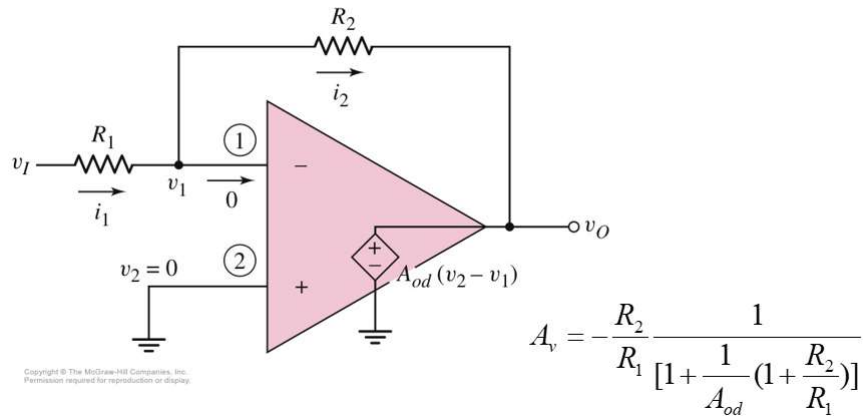
Problem-Solving Technique: Ideal Op-Amp Circuits

1. If noninverting terminal is grounded, then inverting terminal is virtual ground.
 - ▶ Sum currents at node assuming no current enters Op Amp
2. If noninverting terminal is not grounded, then inverting terminal voltage is equal to that of the noninverting terminal.
 - ▶ Sum currents at node assuming no current enters Op Amp.
 - ▶ Output voltage is determined from either Step 1 or 2.

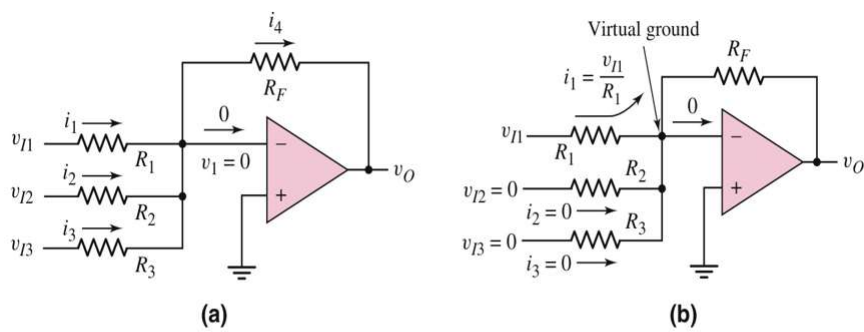
Inverting Op-Amp with T-Network



Inverting Op-Amp with Finite Differential-Mode Gain

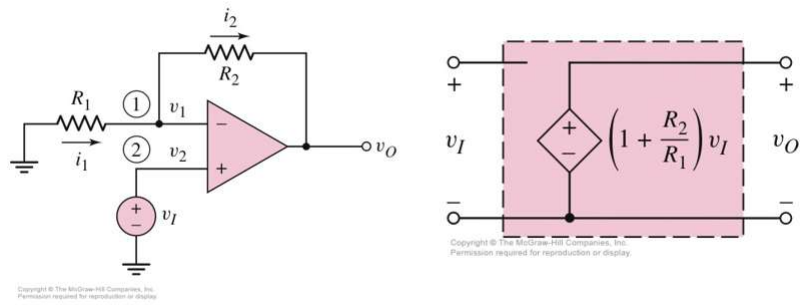


Summing Op-Amp

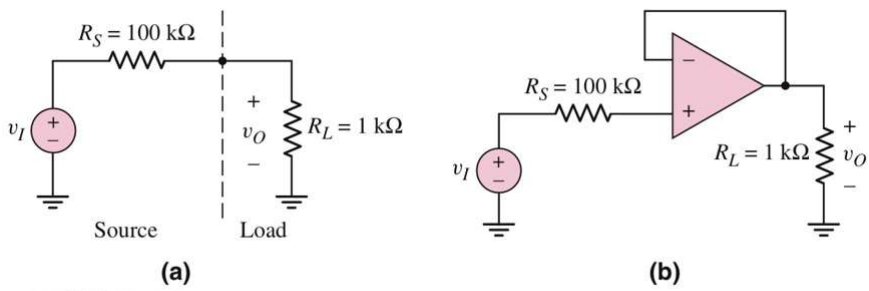


$$v_O = -\left(\frac{R_F}{R_1} v_{I1} + \frac{R_F}{R_2} v_{I2} + \frac{R_F}{R_3} v_{I3}\right)$$

Noninverting Op-Amp

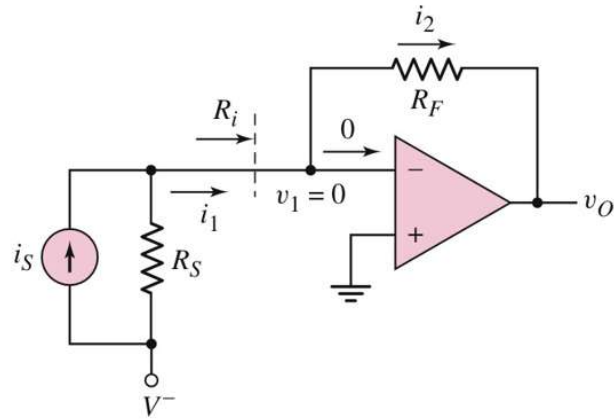


Voltage Follower

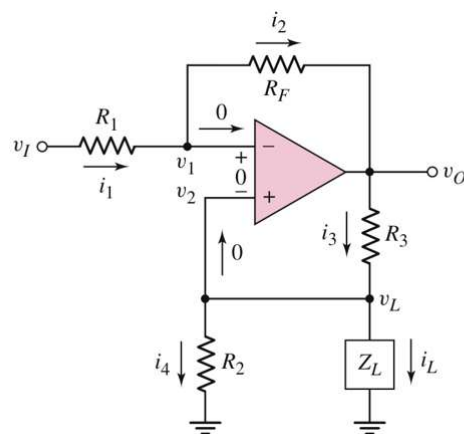


$$\frac{v_O}{v_I} = \frac{R_L}{R_L + R_S}$$

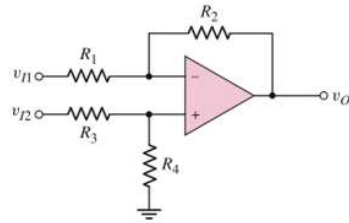
Current-to-Voltage Converter



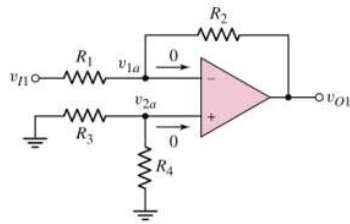
Voltage-to-Current Converter



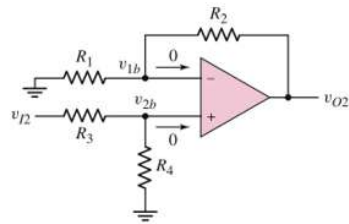
Op-Amp Difference Amplifier



(a)

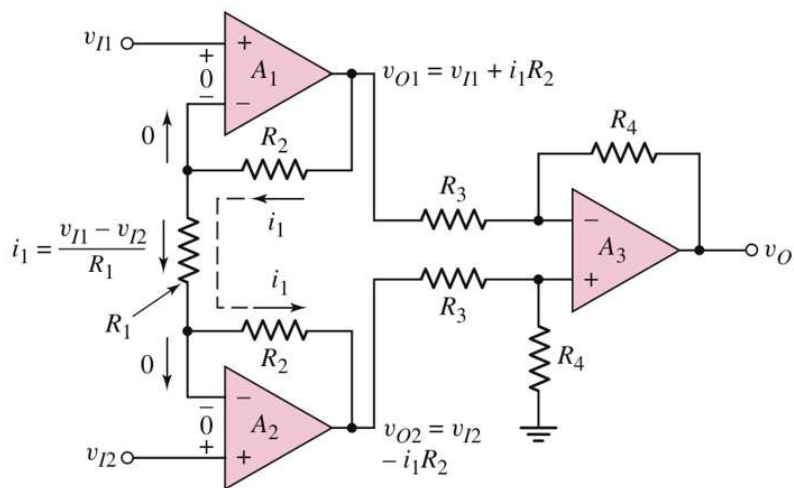


(b)

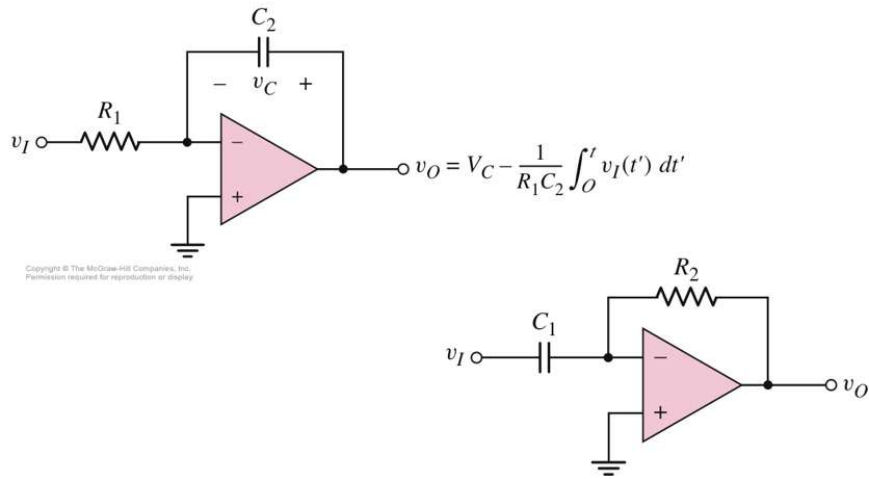


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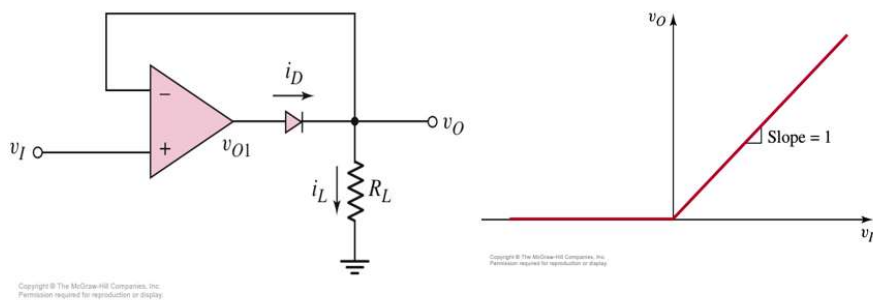
Instrumentation Amplifier



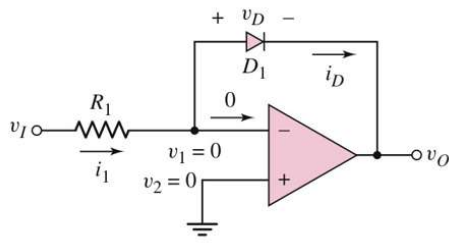
Op-Amp Integrator and Differentiator



Precision Half-Wave Rectifier



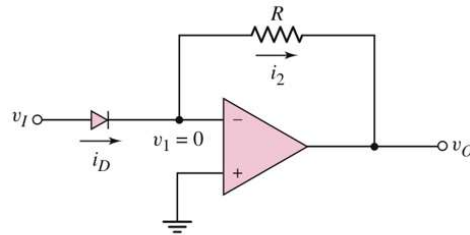
Log and Antilog Amplifiers



Log Amplifier

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Antilog Amplifier



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Op-Amp Voltage Reference Circuit

