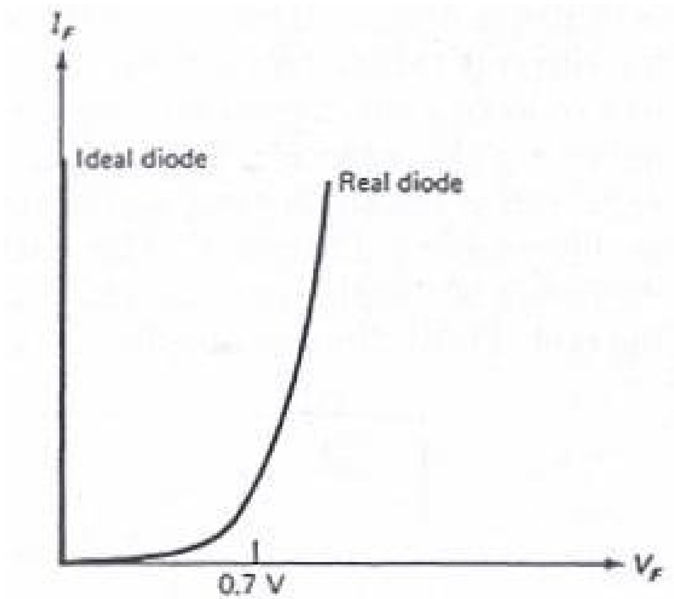
UNIT-4
Lecture-2

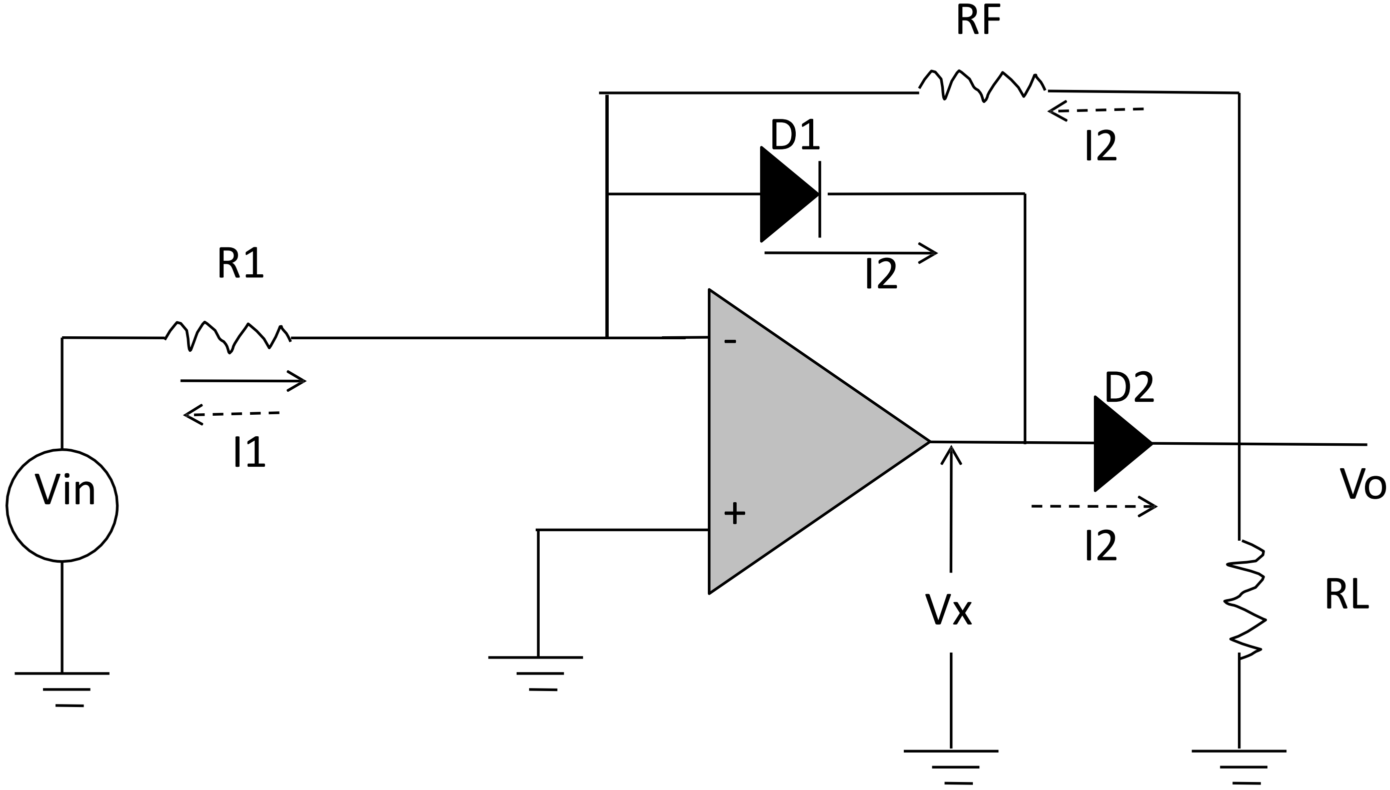
Precision Rectifiers, Op-amp as a comparator

Precision Rectifiers

- Op amps can be used to form nearly ideal rectifiers (convert ac to dc)
- Idea is to use negative feedback to make op amp behave like a rectifier with near-zero barrier potential and with linear I/O characteristic
- Transconductance curves for typical silicon diode and an ideal diode

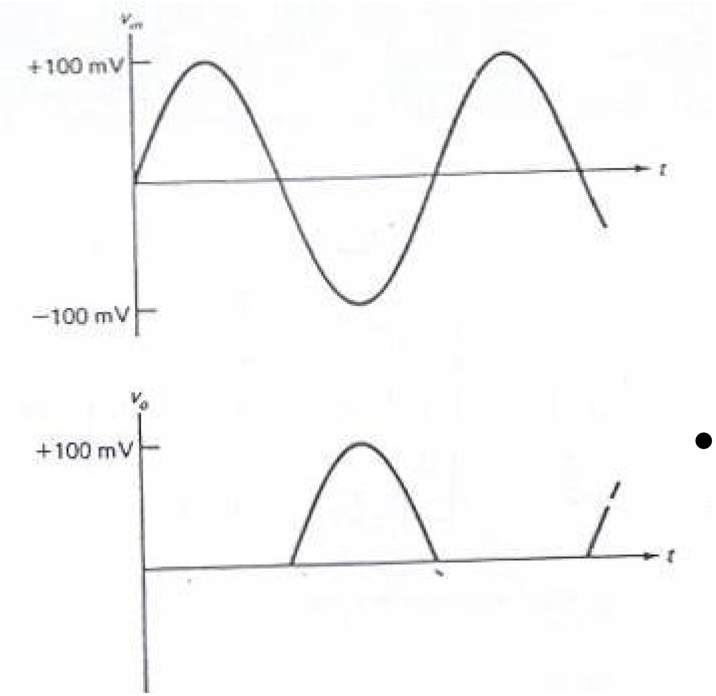


Precision Half-Wave Rectifier



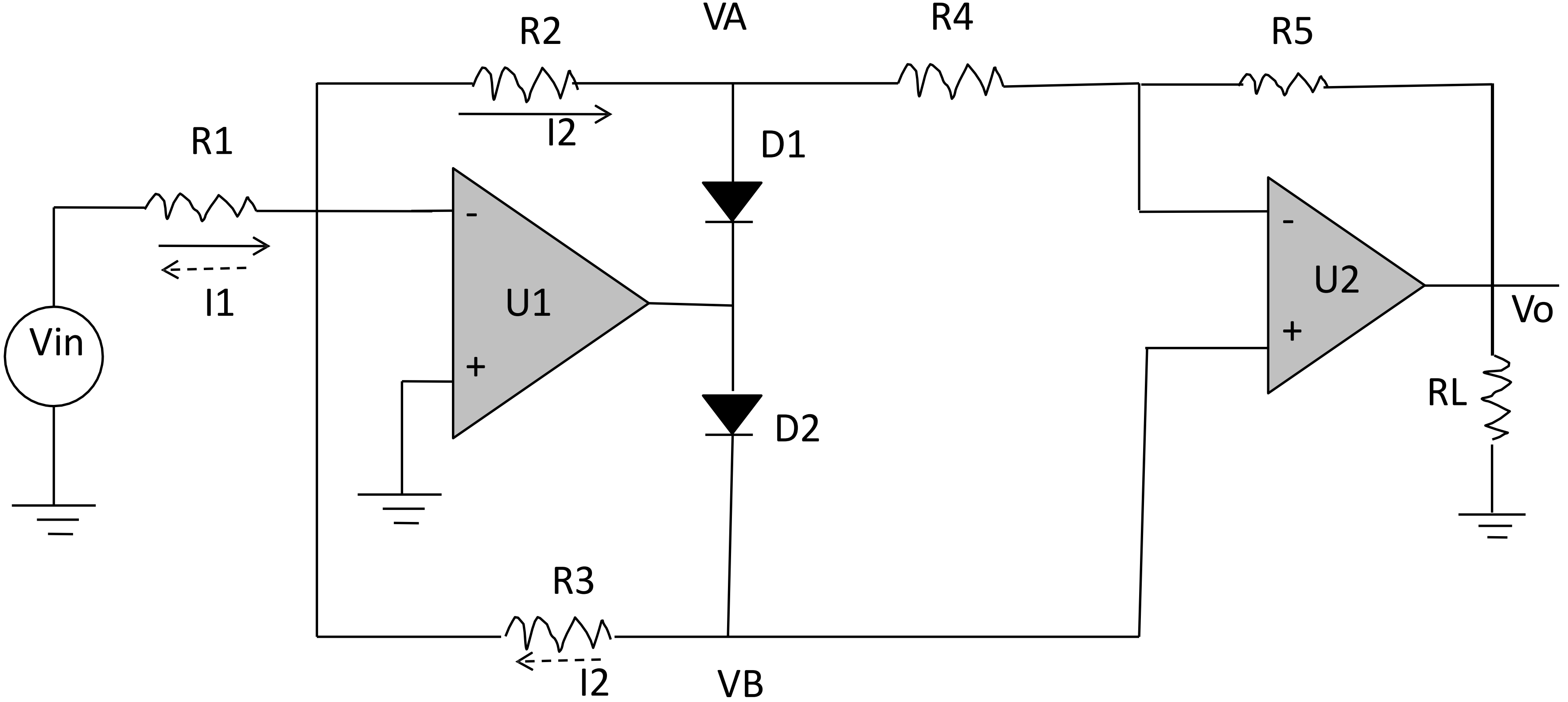
- Solid arrows represent current flow for positive half-cycles of V_{in} and dashed arrows represent current flow for negative half-cycles

Precision Half-Wave Rectifier



- If signal source is going positive, output of op amp begins to go negative, forward biasing D_1
  - Since D_1 is forward biased, output of op amp V_x will reach a maximum level of ~ -0.7V regardless of how far positive V_{in} goes
  - This is insufficient to appreciably forward bias D_2, and V_0 remains at 0V
- On negative-going half-cycles, D_1 is reverse-biased and D_2 is forward biased
  - Negative feedback reduces barrier potential of D_2 to $0.7V/A_{OL}$ (~ = 0)
  - Gain of circuit to negative-going portions of V_{in} is given by $A_V = -R_F/R_1$

Precision Full-Wave Rectifier

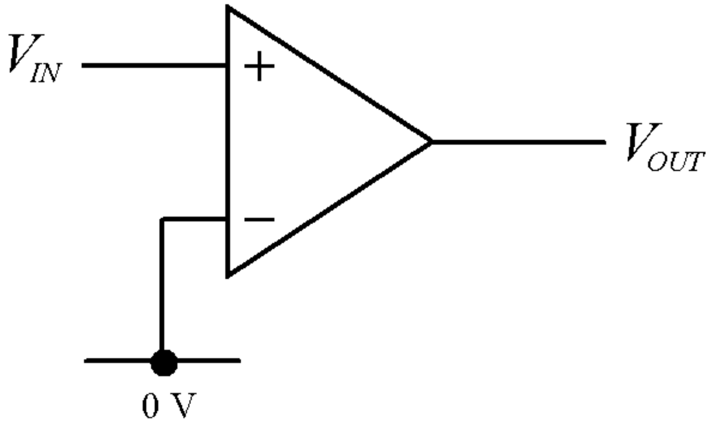


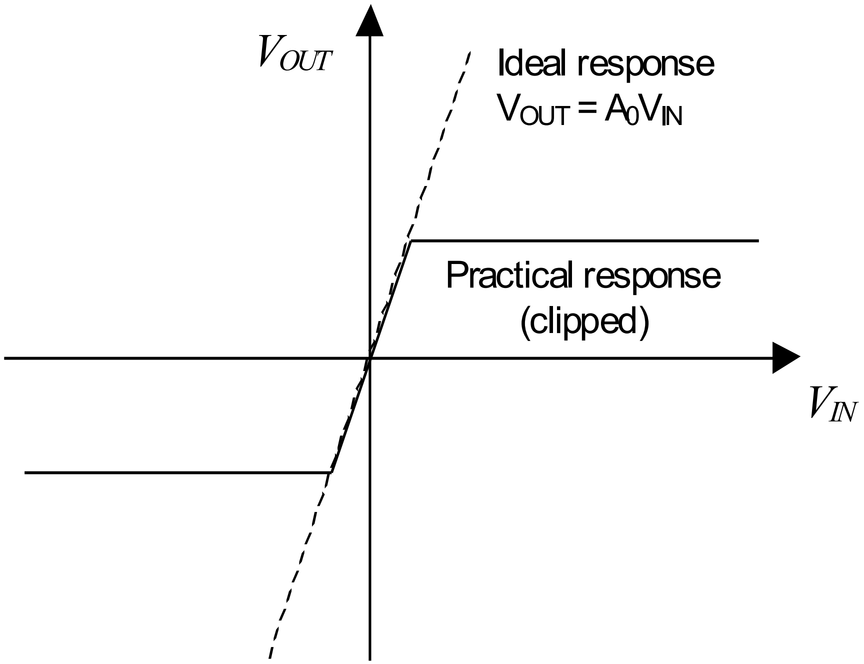
- Solid arrows represent current flow for positive half-cycles of V_{in} and dashed arrows represent current flow for negative half-cycles

Precision Full-Wave Rectifier

- Positive half-cycle causes D_1 to become forward-biased, while reverse-biasing D_2
  - $V_B = 0$ V
  - $V_A = -V_{in} R_2/R_1$
  - Output of U_2 is $V_0 = -V_A R_5/R_4 = V_{in} (R_2R_5/R_1R_4)$
- Negative half-cycle causes U_1 output positive, forward-biasing D_2 and reverse-biasing D_1
  - $V_A = 0$ V
  - $V_B = -V_{in} R_3/R_1$
  - Output of U_2 (noninverting configuration) is
    $V_0 = V_B [1+ (R_5/R_4)]= - V_{in} [(R_3/R_1)+(R_3R_5/R_1R_4)$
  - if $R_3 = R_1/2$, both half-cycles will receive equal gain

Comparators





If A_0 is large, practical response can be approximated as :

$$V_{IN} > 0 \Rightarrow V_+ > V_- \Rightarrow V_{OUT} = +V_{SAT}$$

$$V_{IN} < 0 \Rightarrow V_+ < V_- \Rightarrow V_{OUT} = -V_{SAT}$$

Hysteresis

- A comparator with hysteresis has a ‘safety margin’.
- One of two thresholds is used depending on the current output state.