EE210: Microelectronics-I

Lecture-2
Amplifier Characteristics-2

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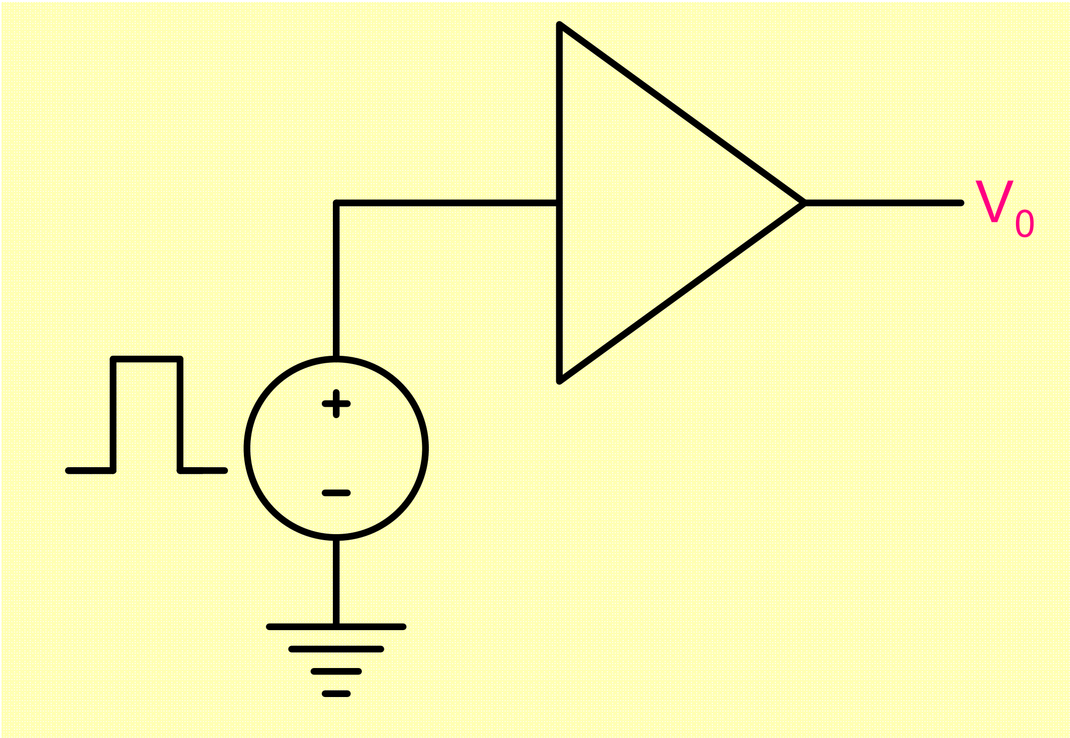
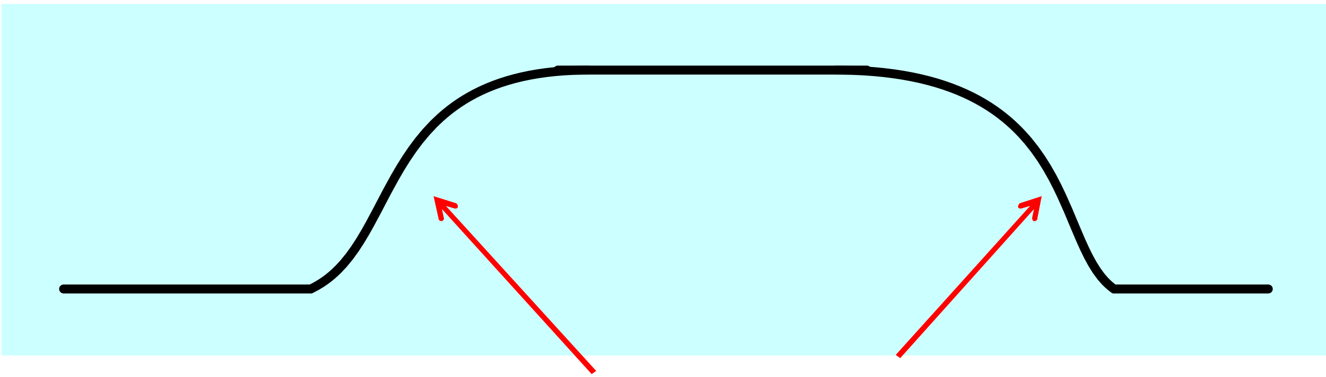
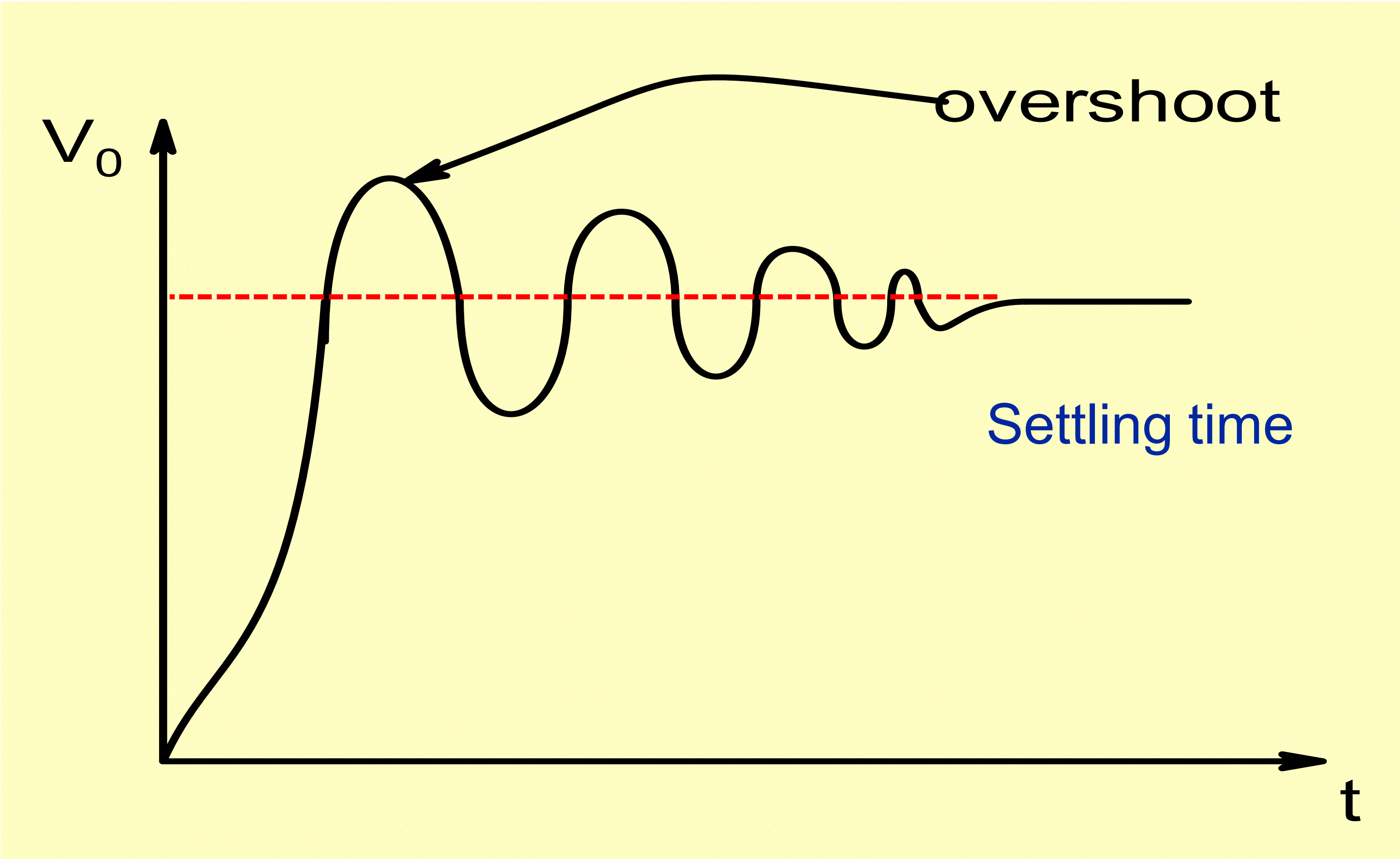
Transient Response





Rise time and fall time

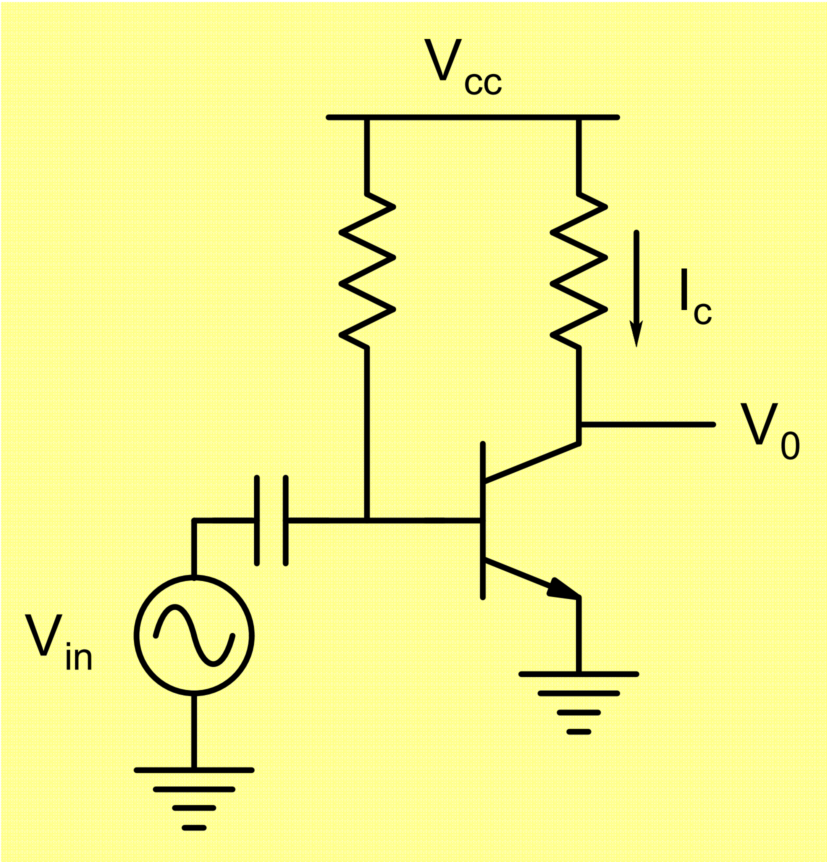
Overshoot and time Settling time

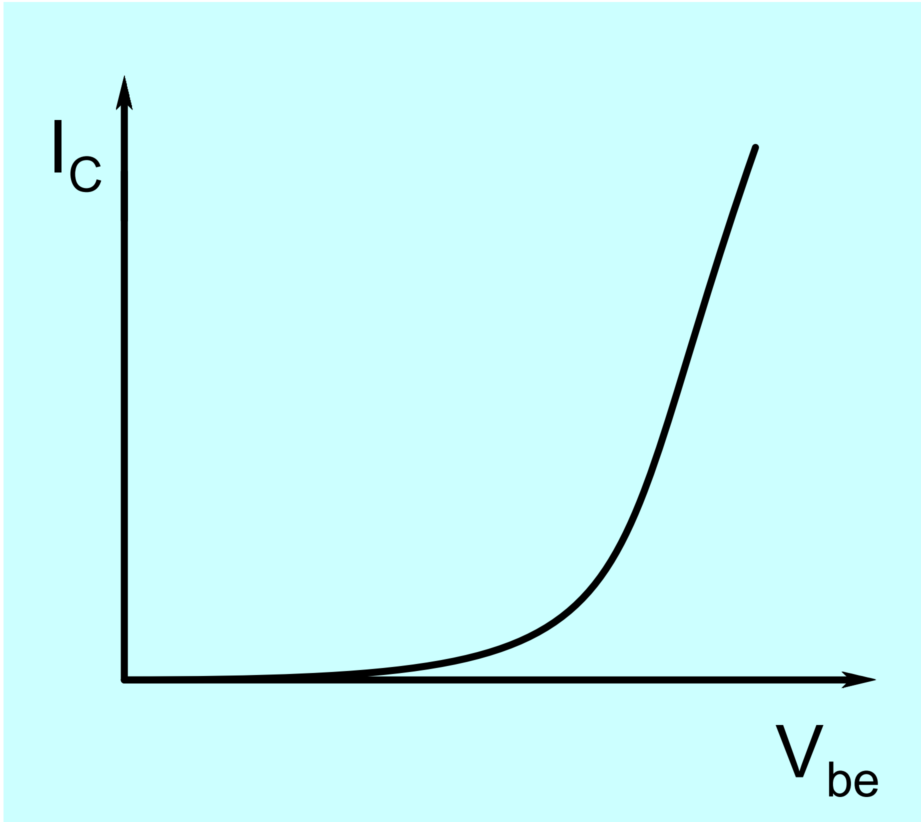


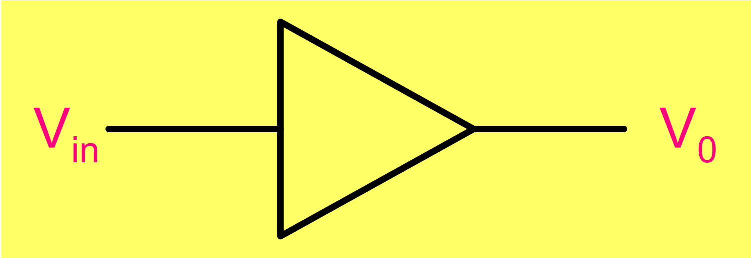
Distortion

$$V_o = A_v(f, V_{in}, R_L, R_S, T) \times v_{in} + \tilde{e}_N$$

All amplifiers are nonlinear because transistors used for building amplifier are nonlinear elements.







$V_{in} = a_0 \sin wt$

$V_0 = b_0 + b_1 \sin \omega t + b_2 \sin 2\omega t + b_3 \sin 3\omega t + \ldots\ldots\ldots\ldots$

$$HD_2 = \frac{b_2}{b_1} \times 100$$

$$HD_3 = \frac{b_3}{b_1} \times 100$$

$$THD = \frac{\sqrt{b_2^{\ 2} + b_3^{\ 2} + \ldots\ldots}}{b_1} \times 100$$

G-Number

Example

$$V_0 = kV_{in} + \frac{k}{10} V_{in}^2$$

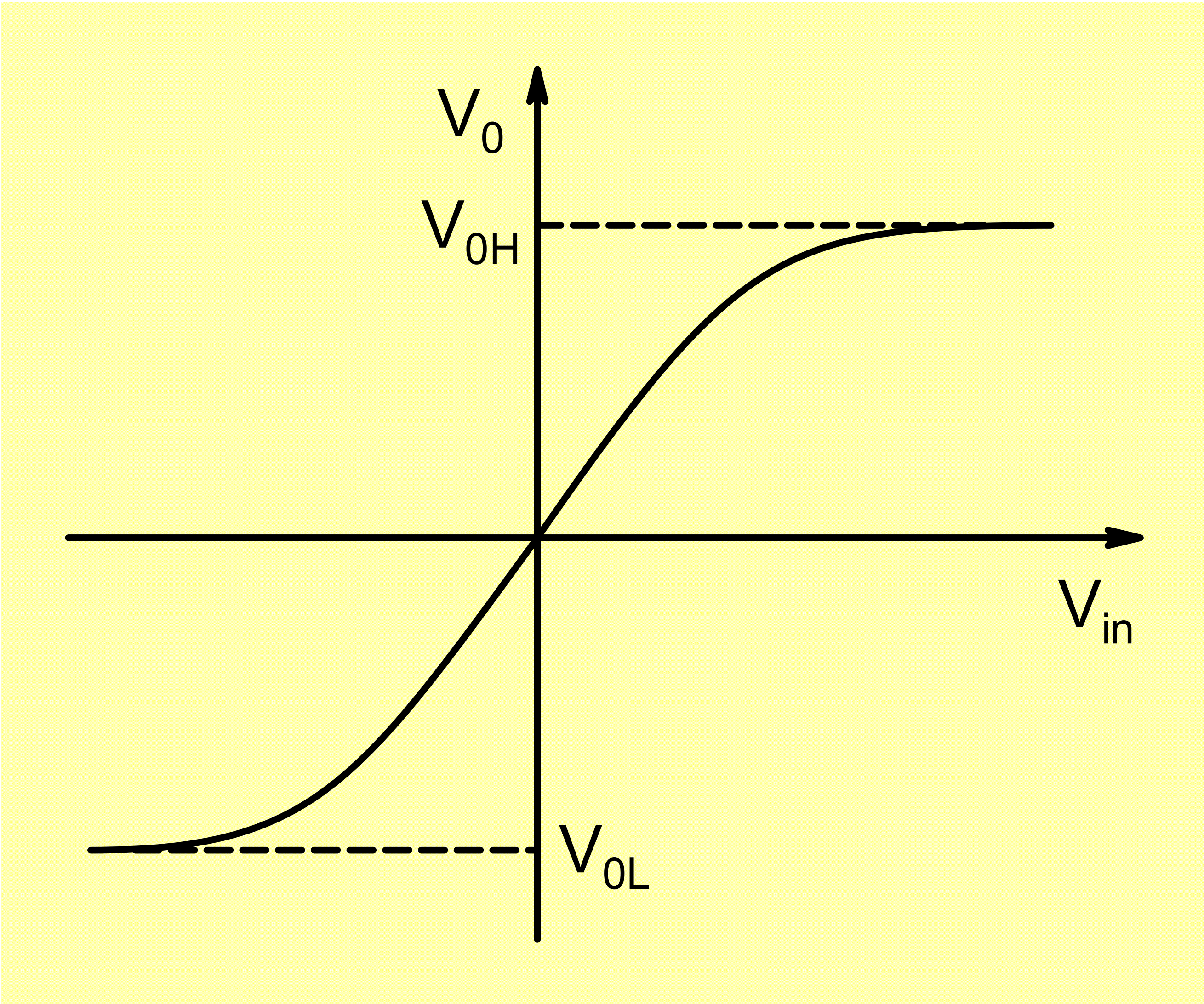
$$V_{in} = a_0 \sin \omega t$$

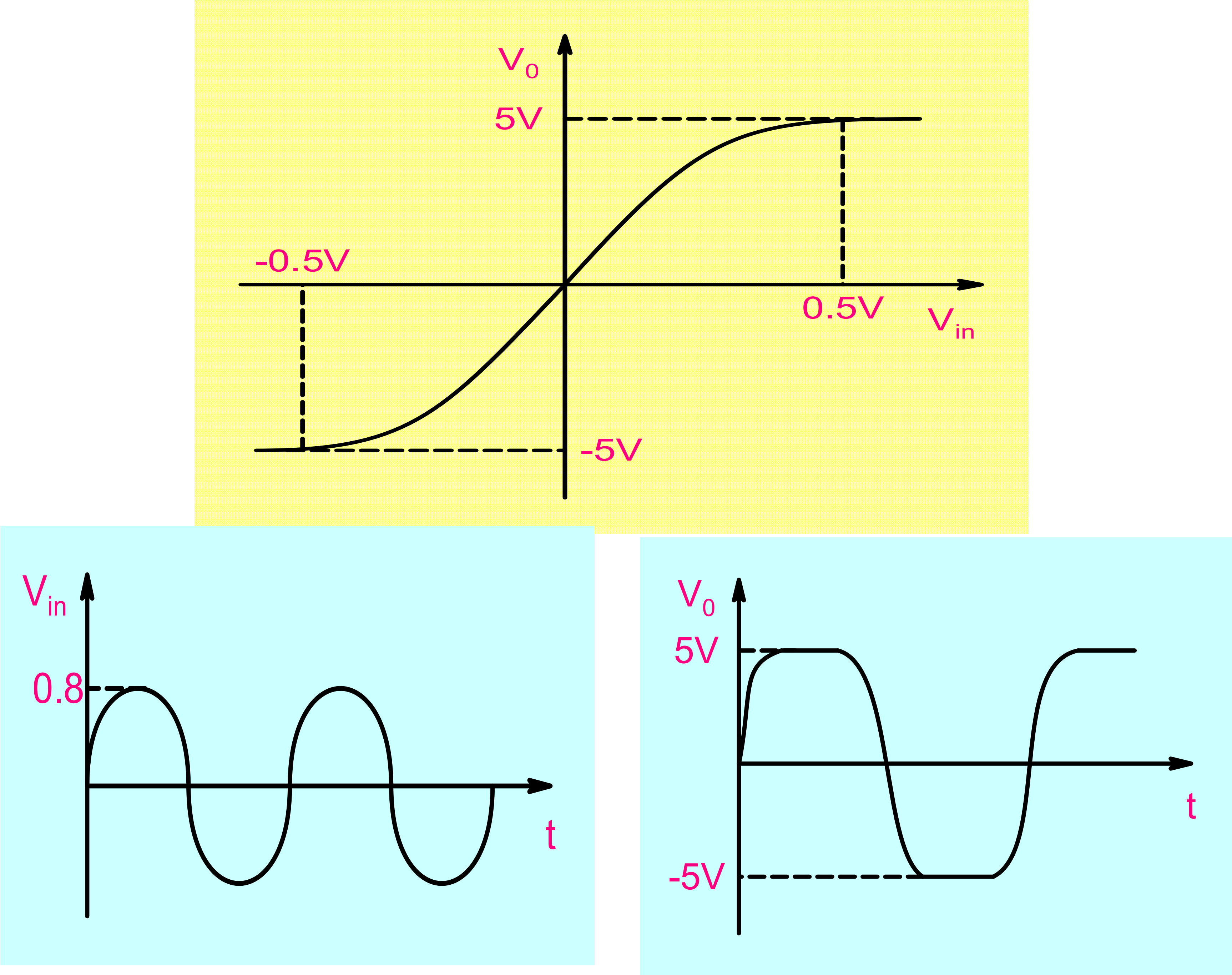
$$V_0 = \frac{ka_0^2}{20} + ka_0 \sin \omega t - \frac{ka_0^2}{20} \cos 2\omega t$$

$$THD = HD_2 = \frac{ka_0^2 / 20}{ka_0} \times 100 = 5a_0$$

Distortion increases with magnitude of input signal !

Maximum Voltage Swing





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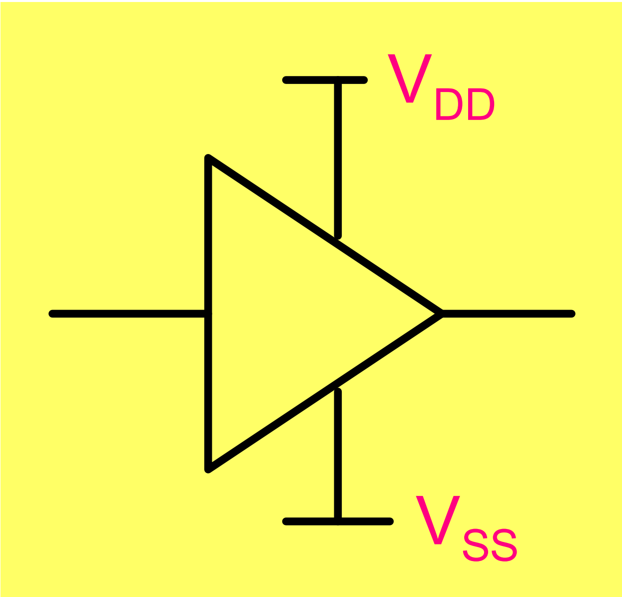
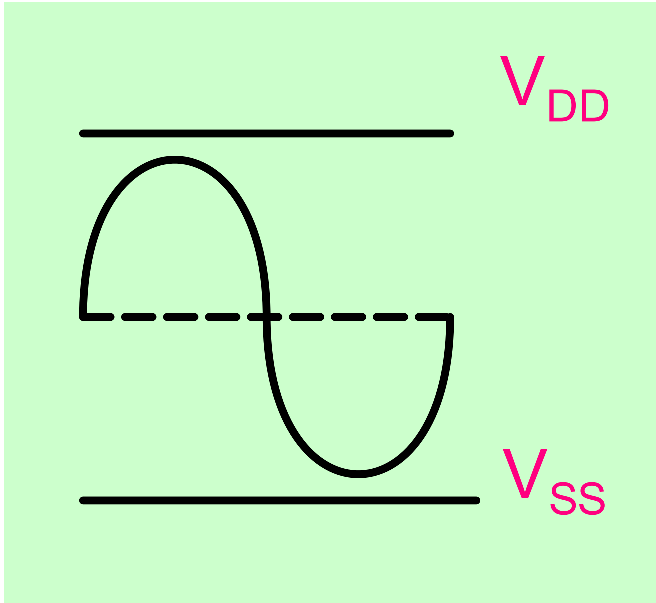
Rail-to-Rail output voltage swing

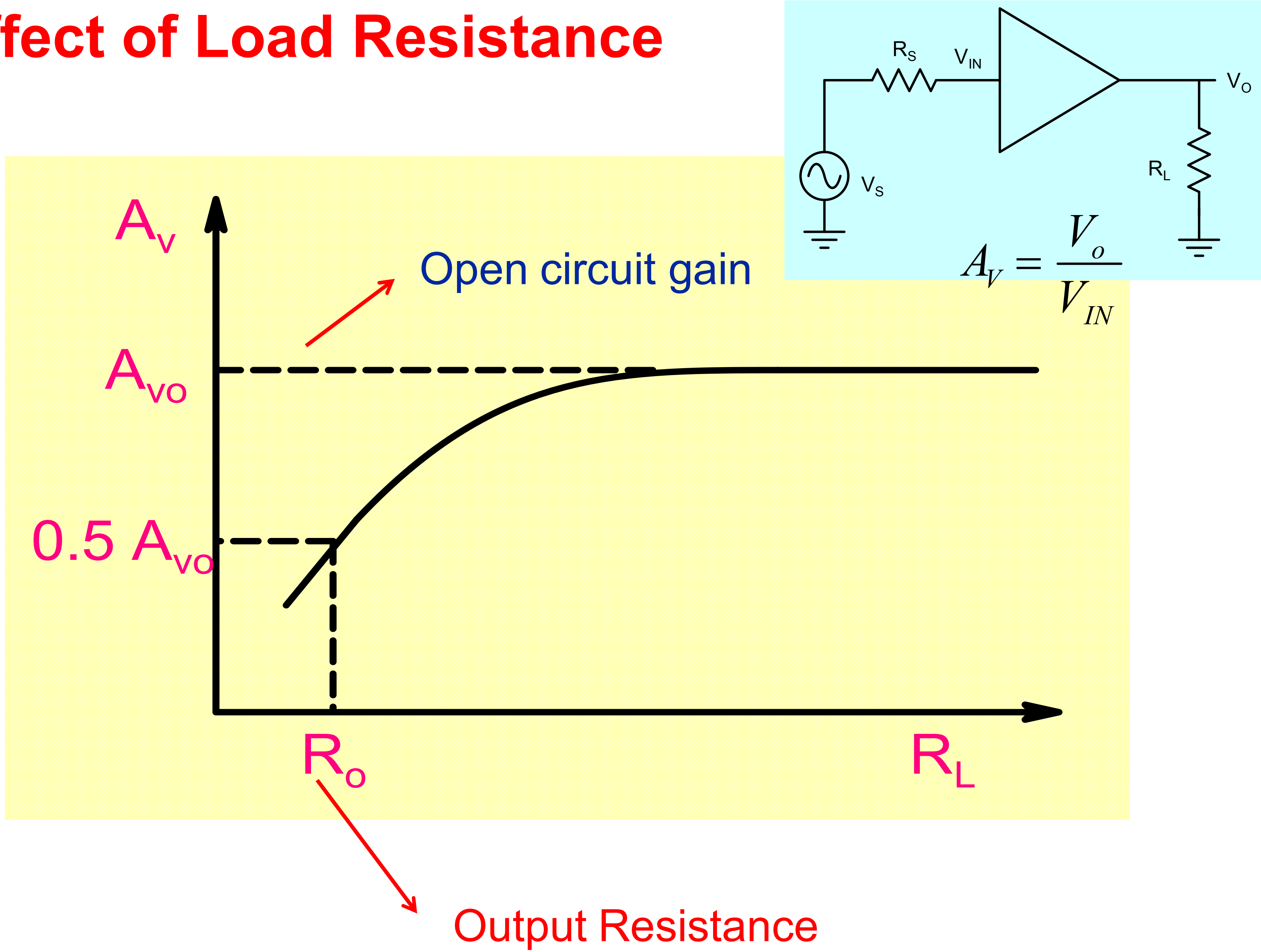
$V_{OH} \leq V_{DD}$ $V_{OL} \geq V_{SS}$





$$V_o = A_v(f, V_{in}, R_L, R_S, T) \times v_{in} + \tilde{e}_N$$

Effect of Load Resistance



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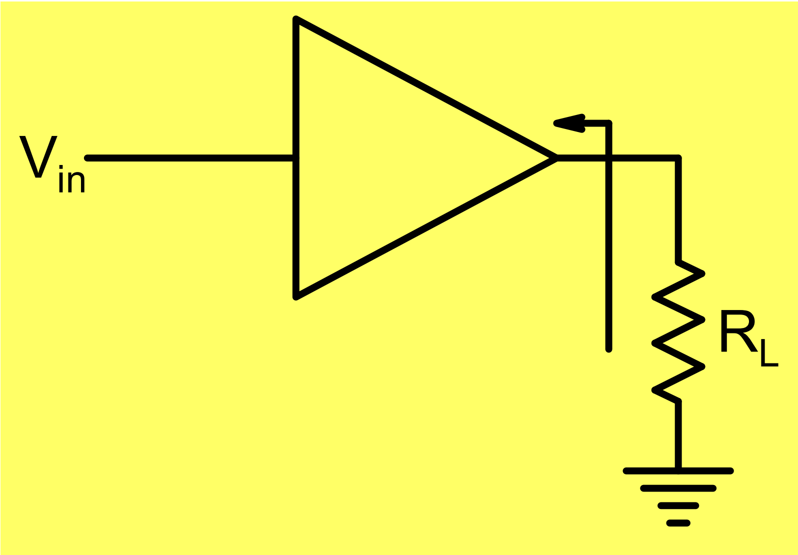
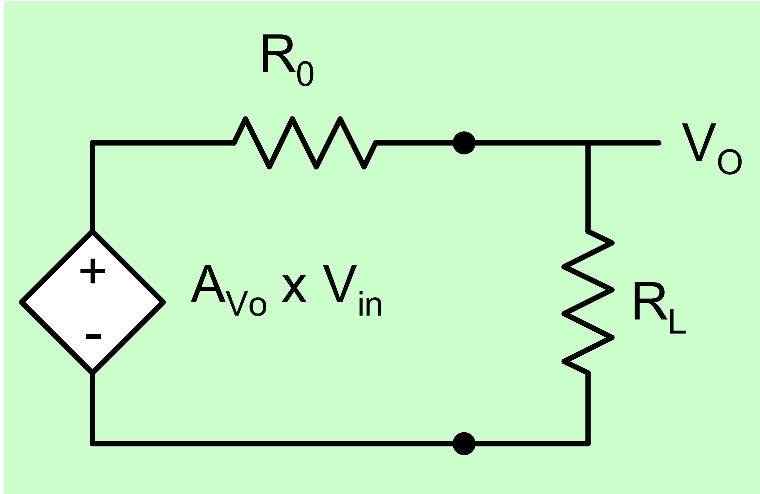
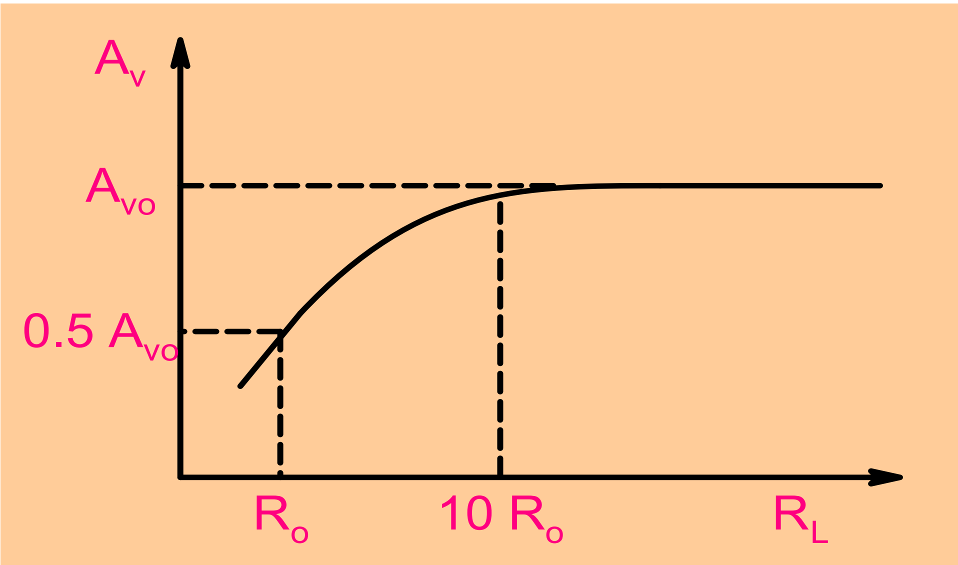
Output Resistance

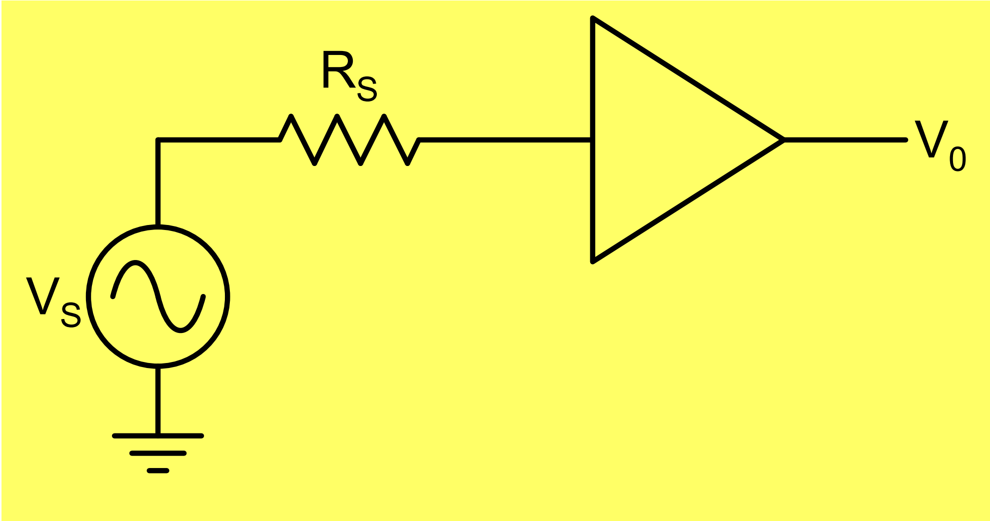




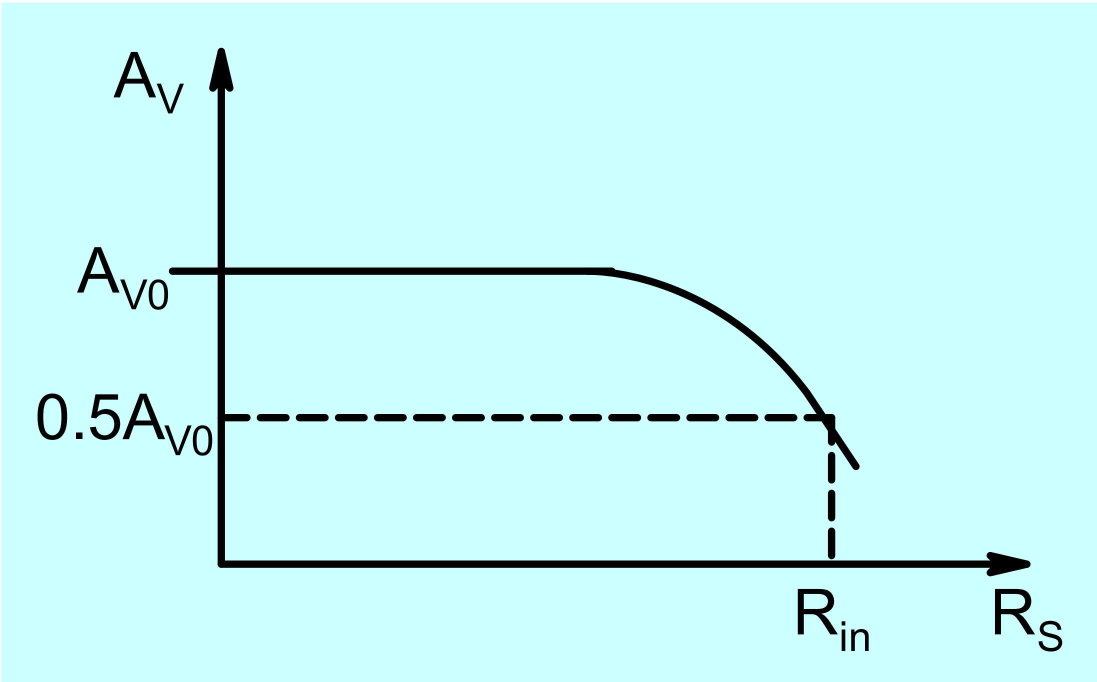


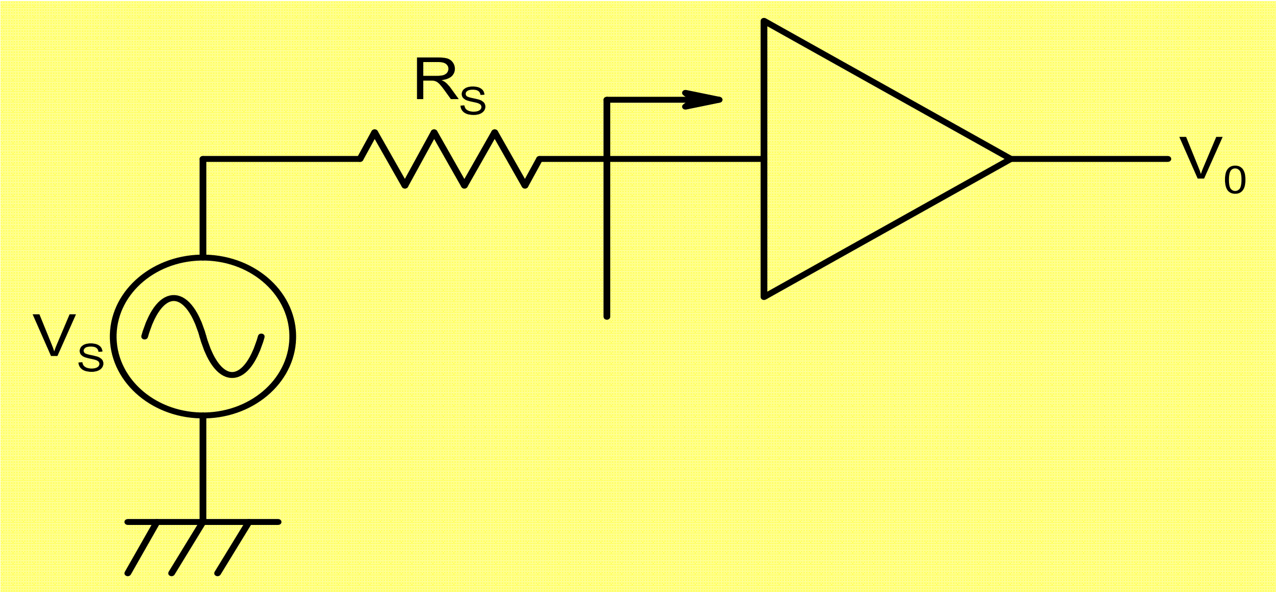
$$V_0 = A_{V0} \times V_{in}\left(\frac{R_L}{R_0 + R_L}\right)$$

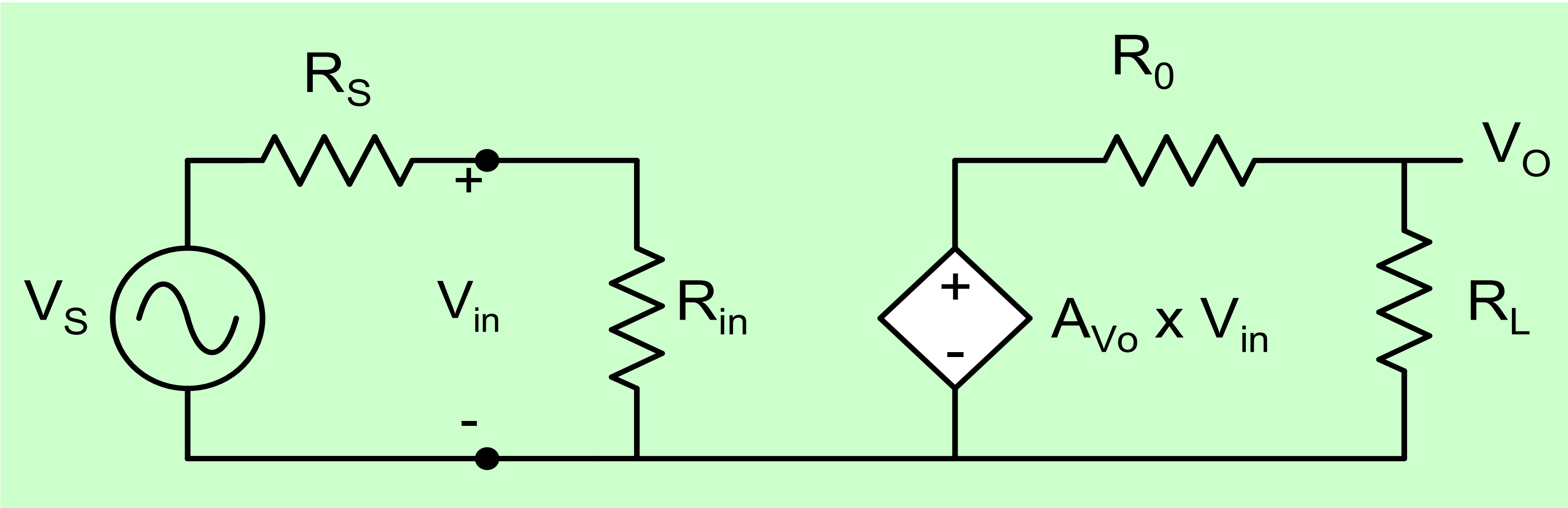
Input Resistance



$$A_{VS} = \frac{V_0}{V_S}$$



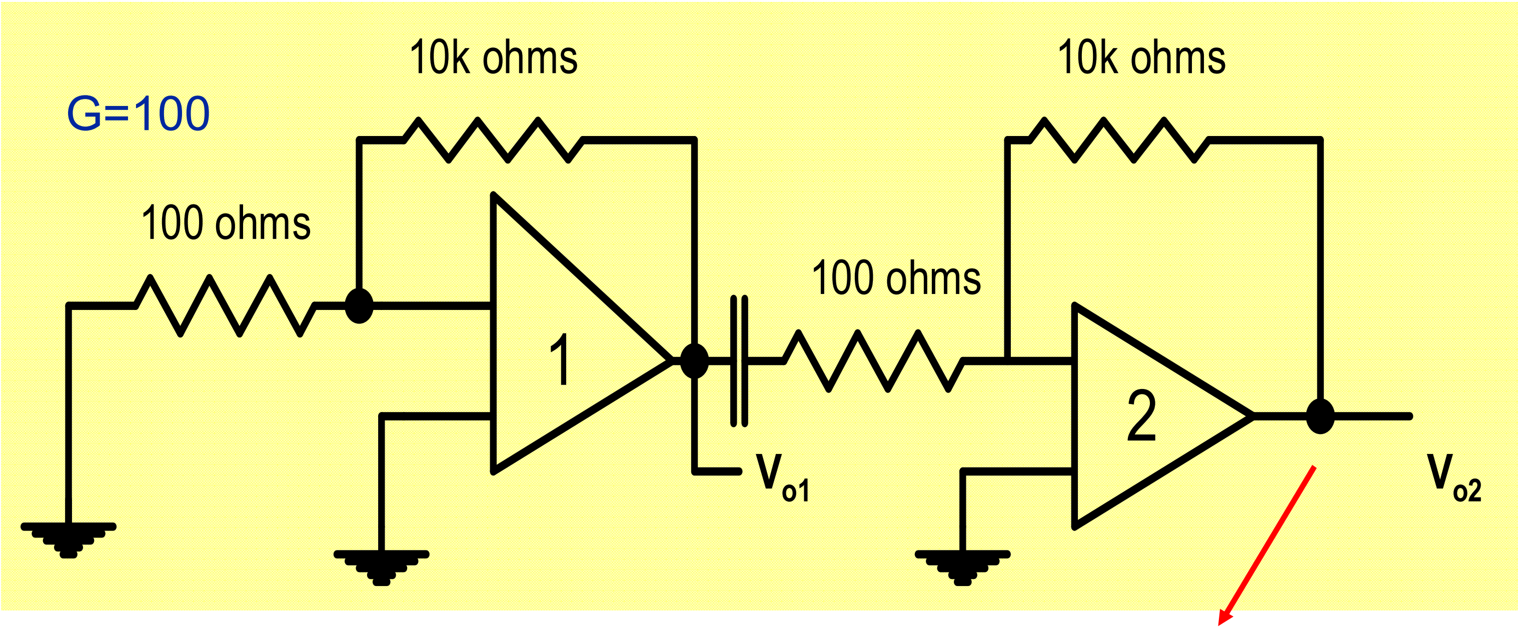


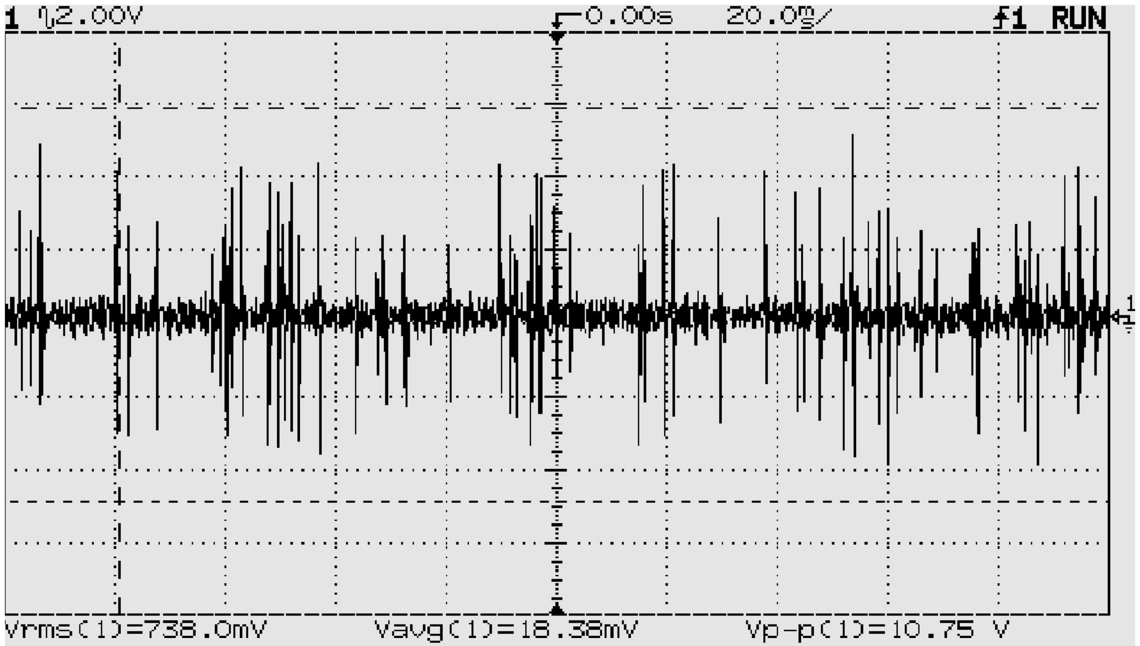


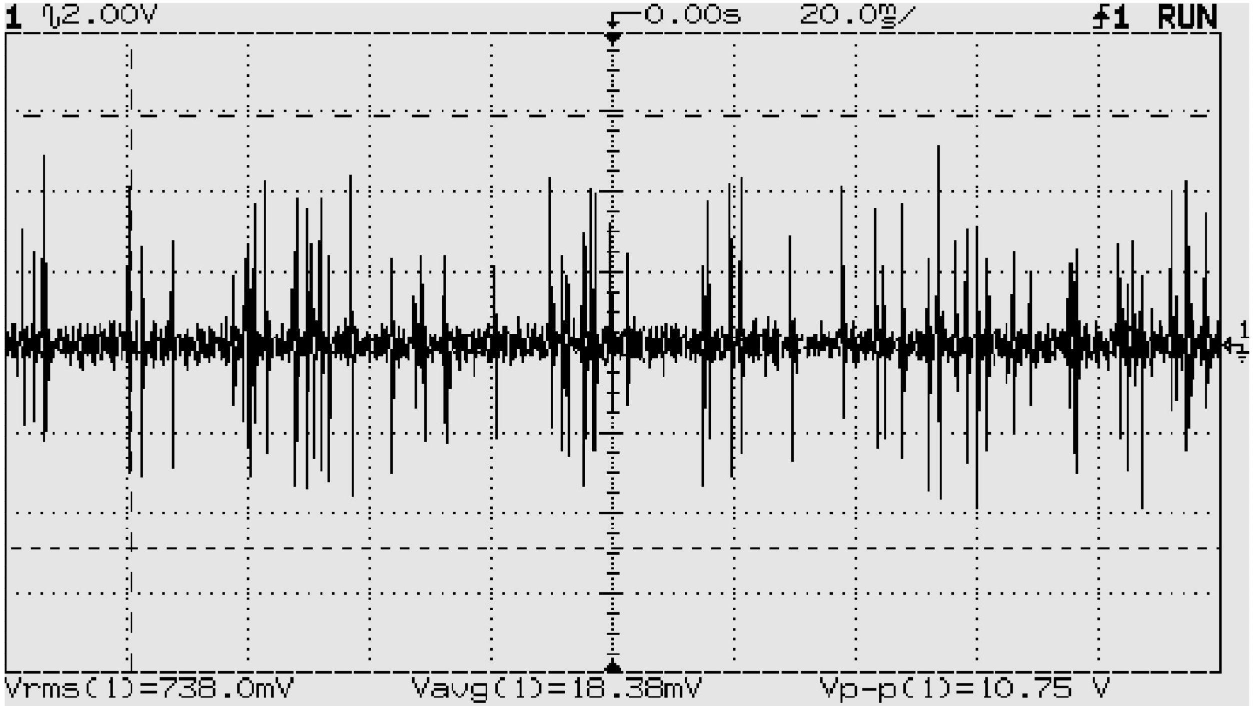
$$A_{VS} = A_{V0} \times \left(\frac{R_{in}}{R_S + R_{in}} \right) \times \left(\frac{R_L}{R_0 + R_L} \right)$$

G-Number

NOISE


G=100
10k ohms
10k ohms
100 ohms
100 ohms
1
2
V_{o1}
V_{o2}


2.00V
0.00s
RUN
Vrms(1)=738.0mV
Vavg(1)=18.38mV
Vp-p(1)=10.75 V



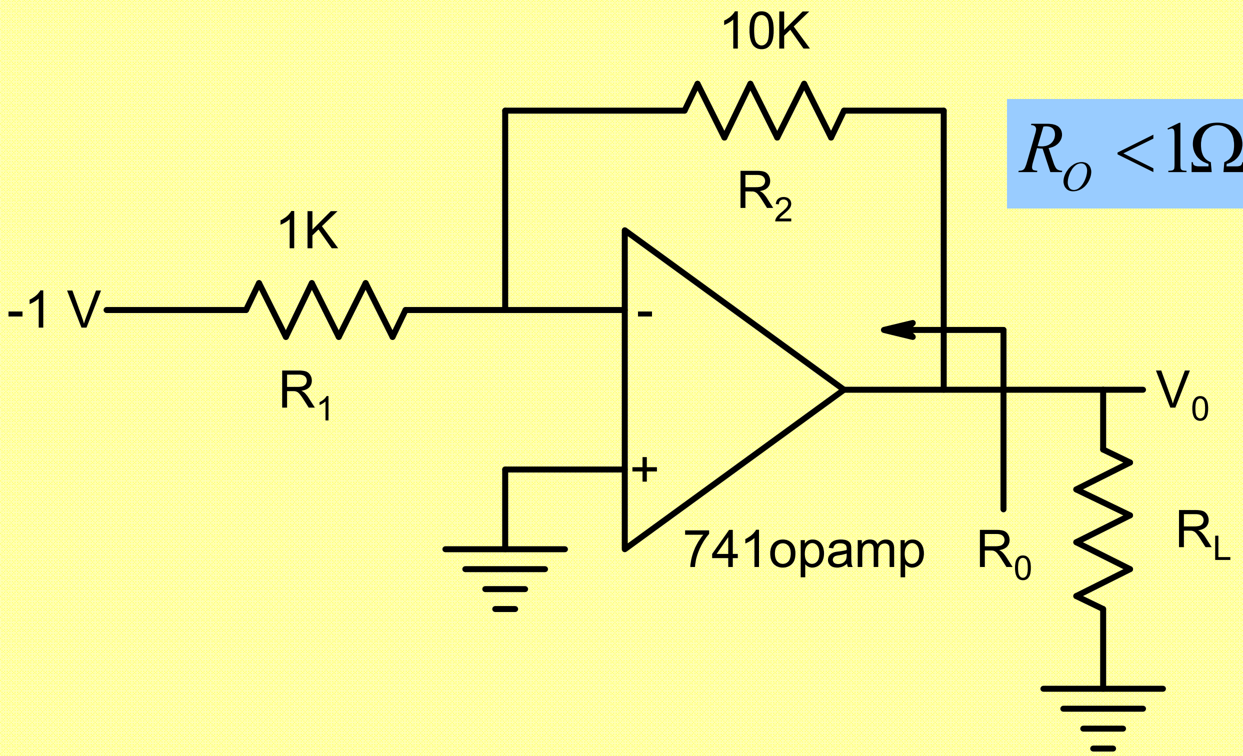
$$F = \frac{\text{Total Output Noise Power}}{\text{Output Noise due to Input Noise Only}}$$

F=1.26

$$\text{Noise Figure : } NF = 10 \times \text{Log}_{10}(F)$$

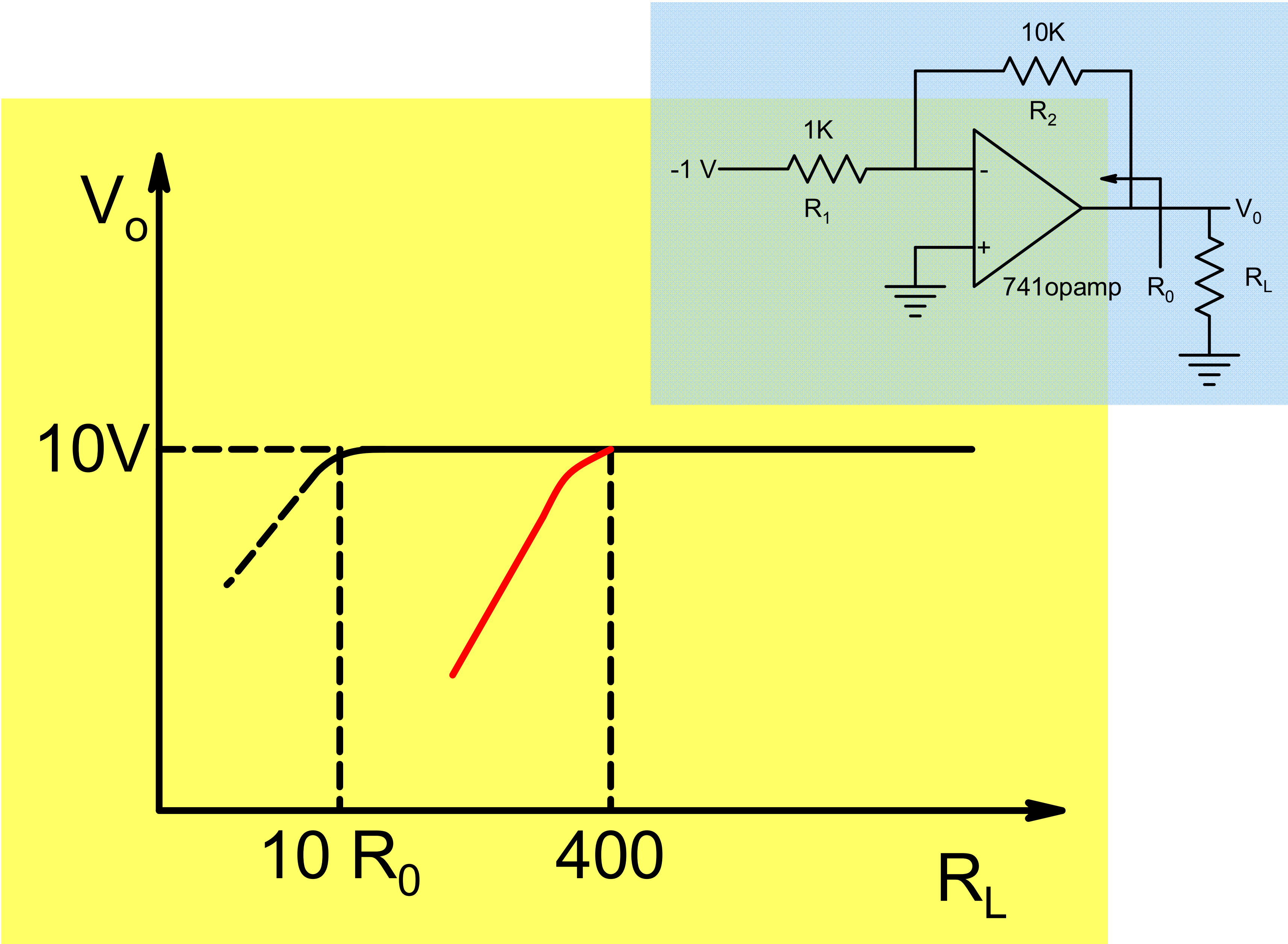
NF=1 dB

Maximum Current Driving Capability



$$R_O < 1\Omega$$

$$V_0 = -\frac{R_2}{R_1} V_{in} = 10V$$



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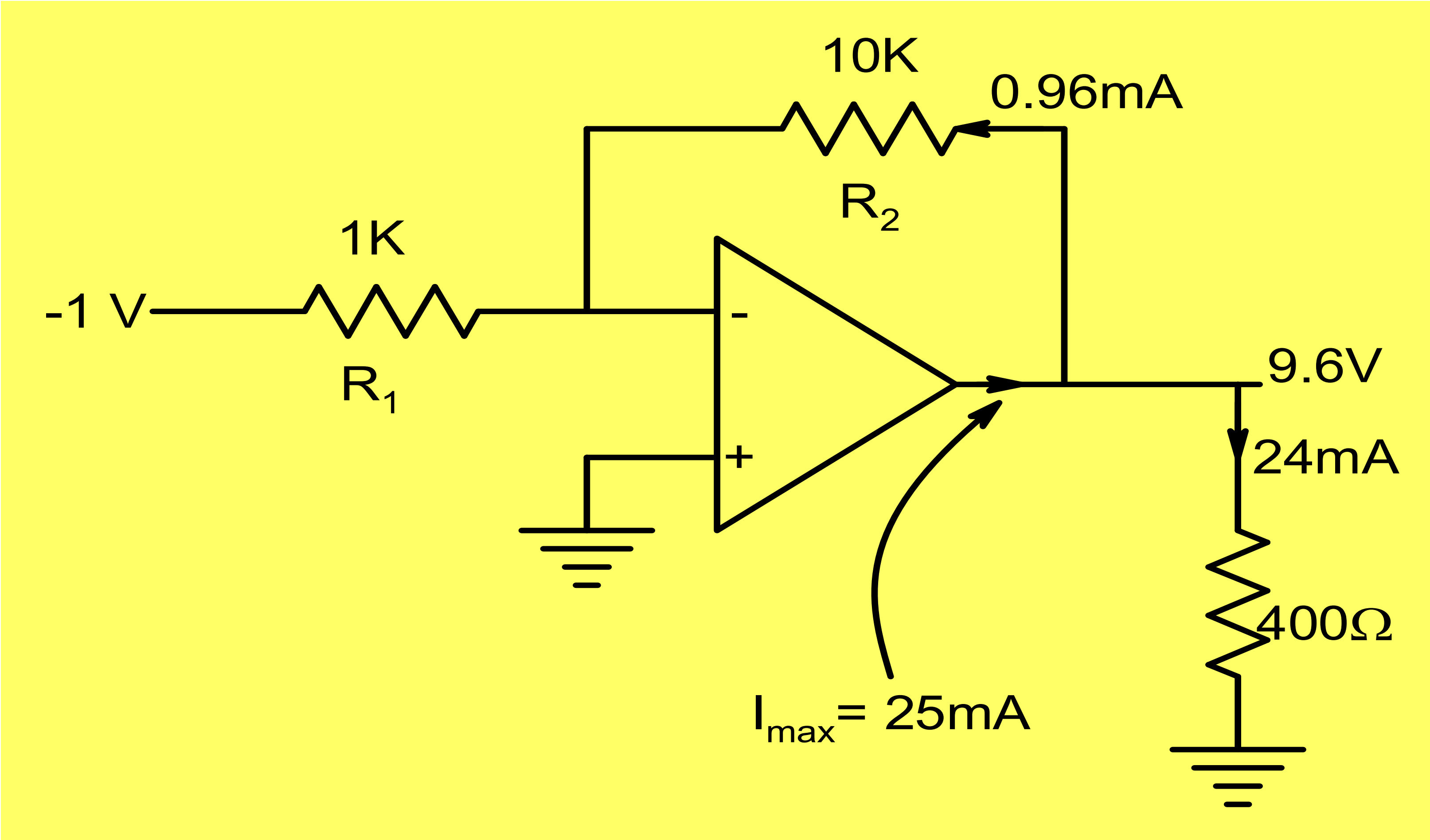
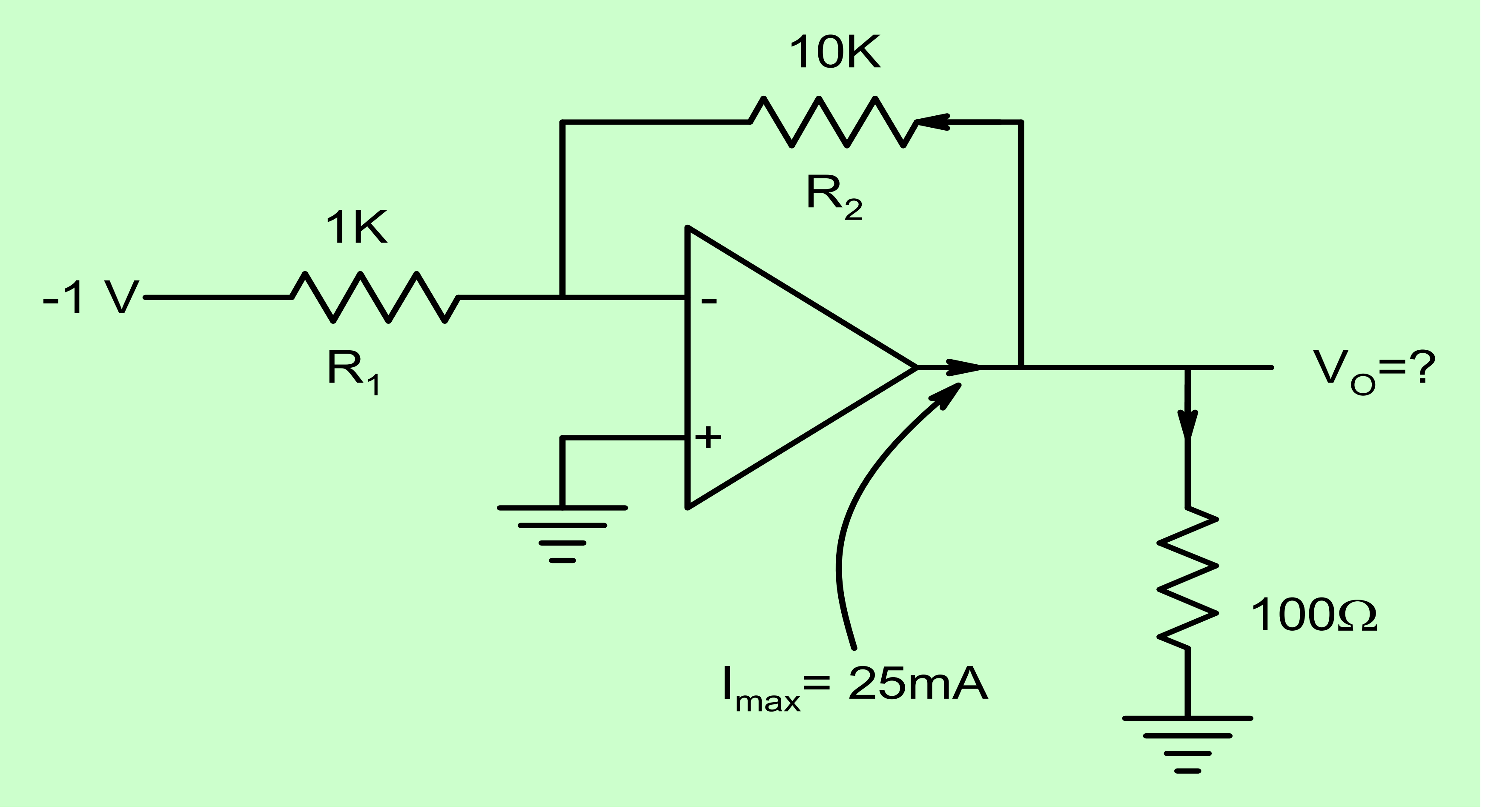
Opamp has maximum current drive capability of 25mA





10K
R_2
1K
-1 V
R_1
-
+
V_O=?
100Ω
I_{max}= 25mA

Summary

$$v_o = A_v(f, V_{in}, R_L, R_S, T) \times v_{in} + \tilde{e}_N$$

A_{Vo}

BW

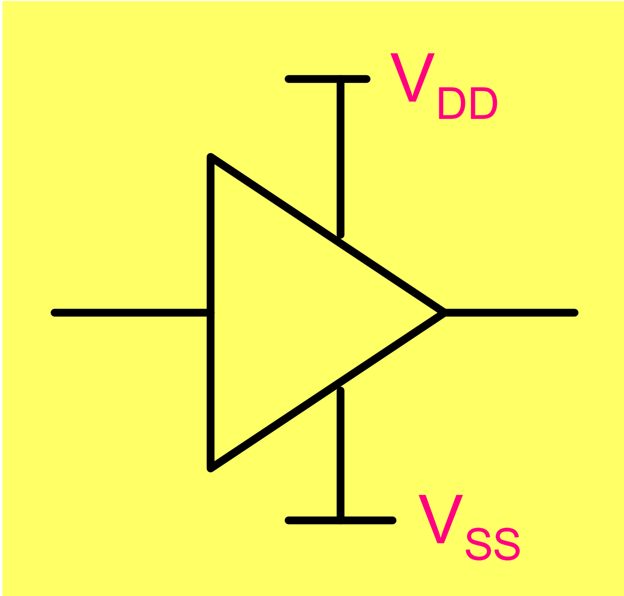
THD

R_O

R_{IN}

NF

Other specifications



$$\eta = \frac{P_L}{P_{\sup ply}}$$

Power supply rejection ratio, common mode rejection ratio…..