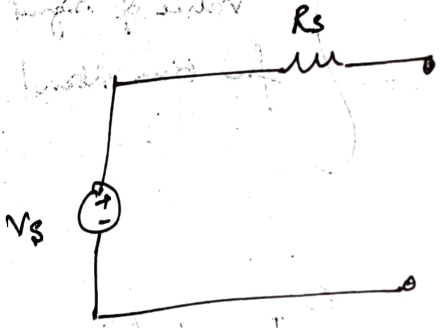
Physical Signal (Sound, Light, etc) → Transducer → Electronic Signal

Device which converts phy. signal to electronic signal

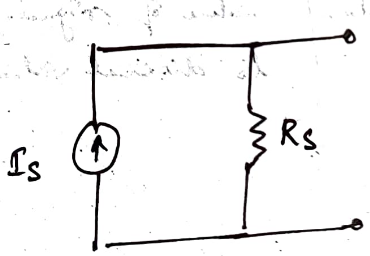
In course we will primarily focus on the transduced output, i.e., the electronic signal.

...

Methods of representing signals:

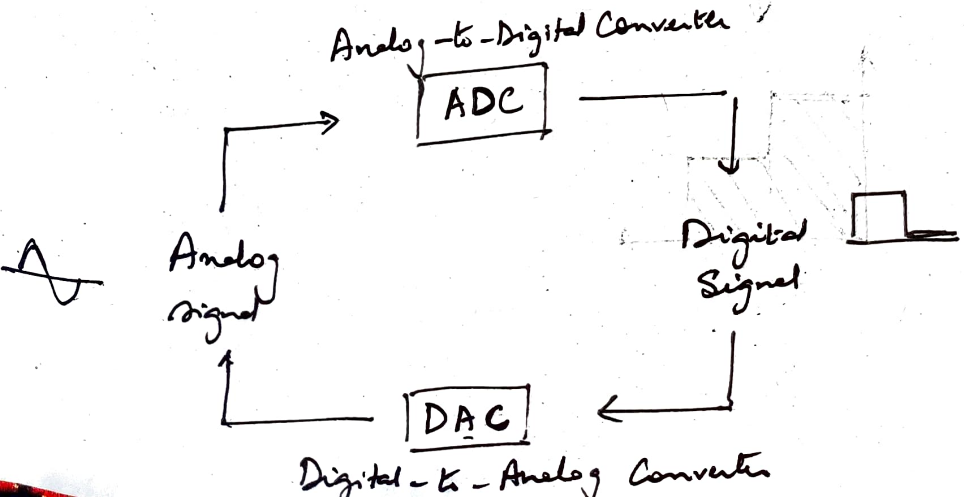


Voltage signal.

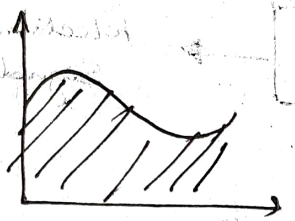


Current signal

...

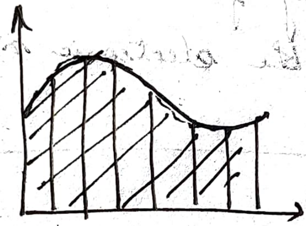


Converting from Analog to Digital:



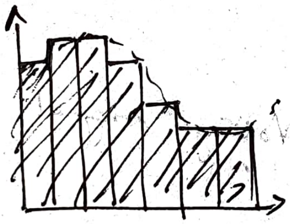
Sampling

Selecting over discrete time intervals



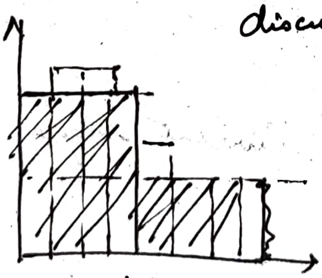
Approximation

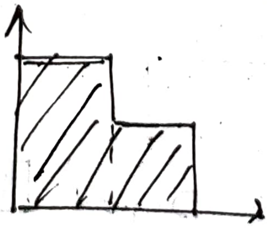
Approximating the value of signal for time interval



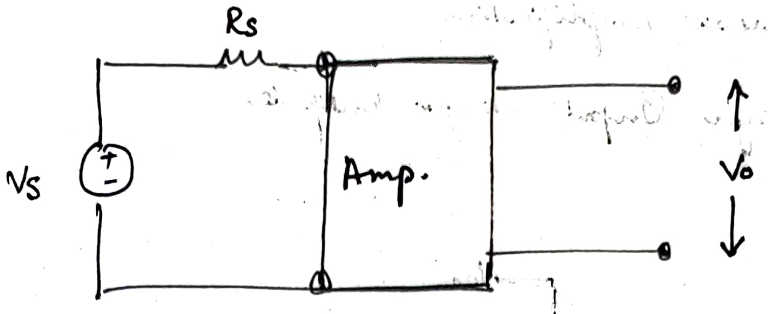
Setting to discrete levels.

Reducing/Increasing value of signals to discrete values





Amplifier:



Generally, there are two types of amplifier.

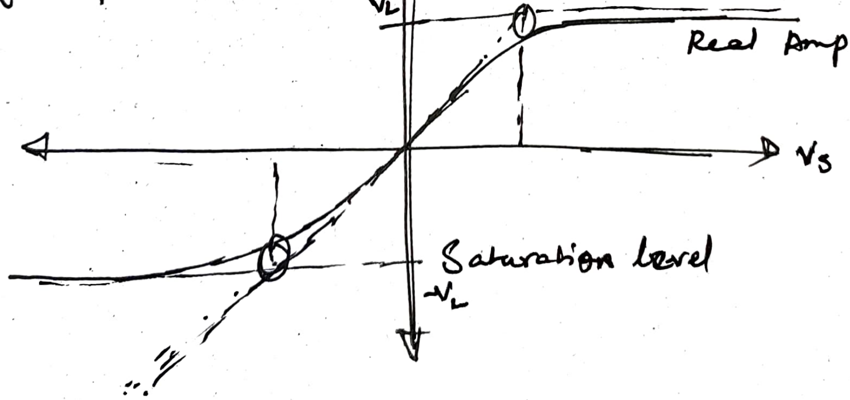
① Linear: $\frac{dV_o}{dV_s} = A$ (constant)

② Non-linear $\frac{dV_o}{dV_s} = f(V_s)$.

In this course, we will focus on only linear amplifier.

Gain of Amplifier (A) $= \frac{V_o}{V_s}$

Slope b/w saturation level: gain of amp. = A

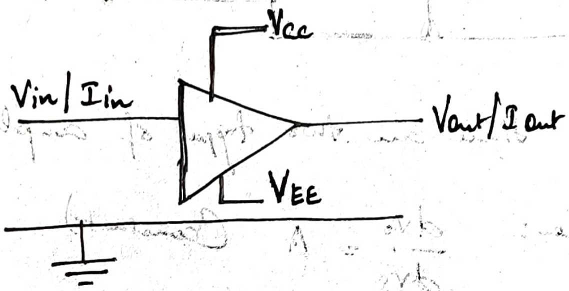


V_L is limited by power supply of the amplifier.

Properties:

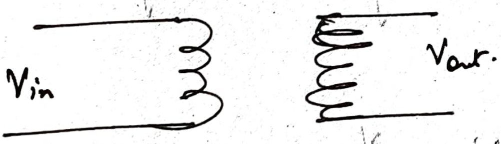
* Linear Amplification
* Single Input Single Output.

Symbol:

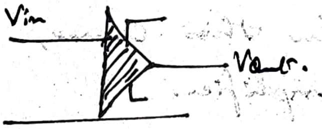


(...)

Transformer v/s Amplifier



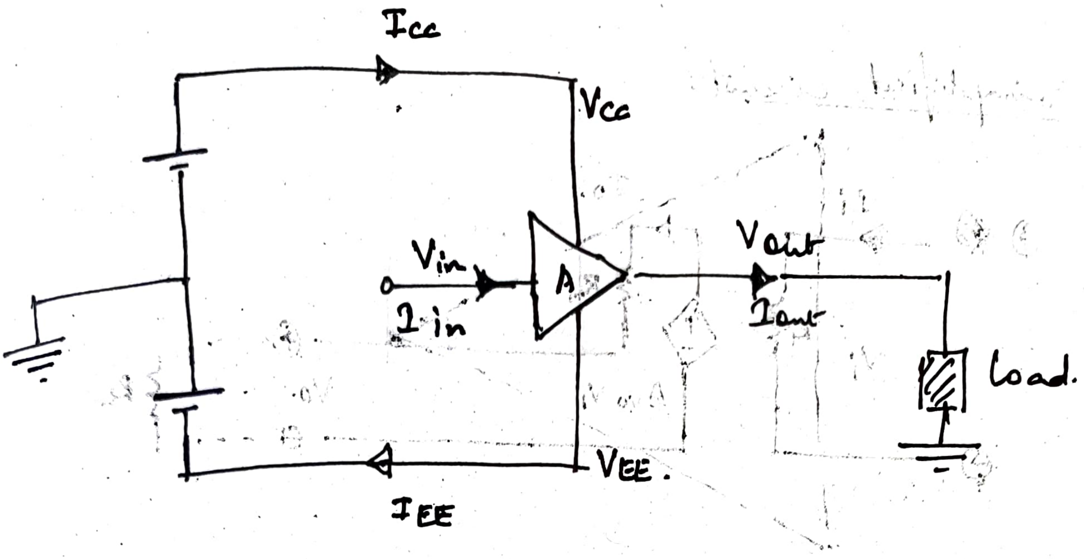
1 : N



Input power $\geq$ Output Power

Input power < Output Power

Amplifier Circuit :



$$\boxed{\frac{P_{out}}{P_{in}} > 1.}$$

$$\boxed{P_{in} + P_{DC} = P_{out} + P_{loss.}}$$

Assuming negligible losses,

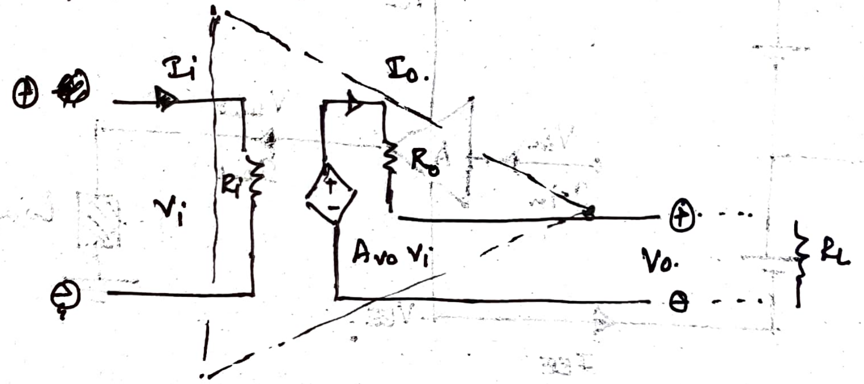
efficiency of amplifier (η)

$$= \frac{V_L \cdot I_L}{P_{DC}} \times 100\%.$$

(where $P_{DC} = V_{cc} \cdot I_{cc} + V_{EE} \cdot I_{EE}$)

Voltage Amplifier: (V_{in}, V_{out}).

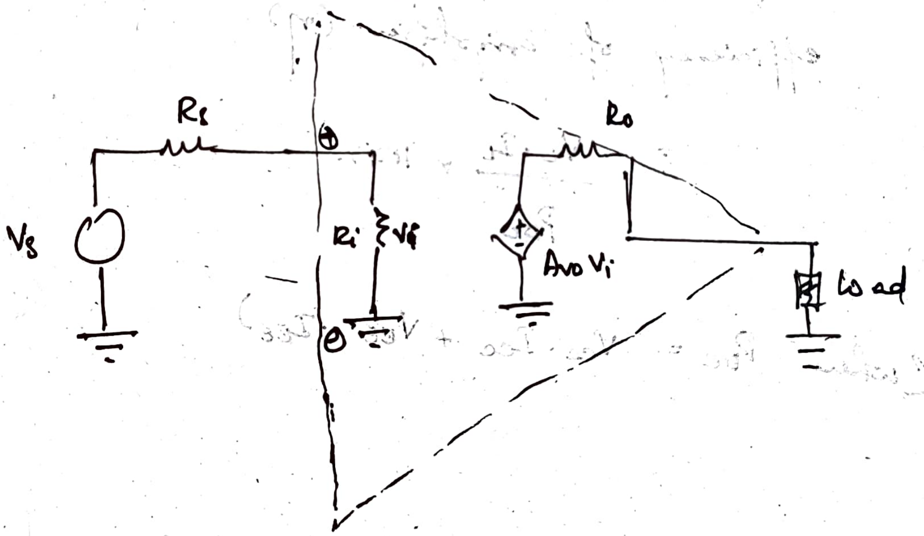
Simplified circuit:



$$\text{Voltage gain} = \frac{V_o}{V_i} = A_{vo}\left[\frac{R_L}{R_o + R_L}\right]$$

for open circuit;

$$\text{gain} = \frac{V_o}{V_i} = A_{vo}$$



$$\text{Gain} = \frac{V_o}{V_s}$$

$$= A_{vo}\left[\frac{R_L}{R_o + R_L}\right]\left[\frac{R_i}{R_s + R_i}\right]$$

for greater efficiency

$R_L >> R_o$ $[R_o \to 0]$

and $R_i >> R_s$ $[R_i \to \infty]$

Other type of Amplifiers:

Current Amplifiers:

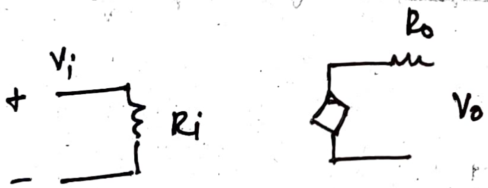
Inp: I
Out: I.

Transconductance / Transadmittance Amplifier:

Inp: V
Out: I

Transresistance / Transimpedance Amplifier:

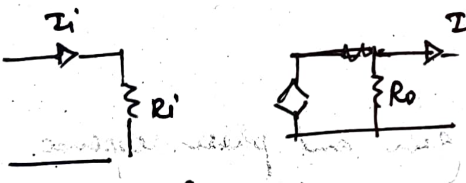
Inp: I
Out: V



Voltage

$R_i \to \infty$

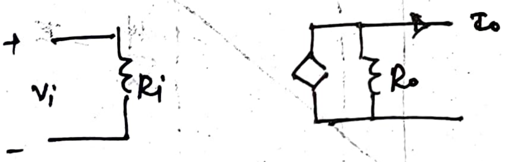
$R_o \to 0.$



Current

$R_i \to 0$

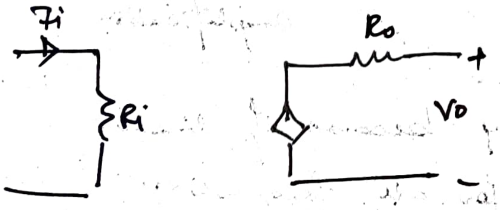
$R_o \to \infty$



Transconductance

$R_i \to \infty$

$R_o \to \infty$

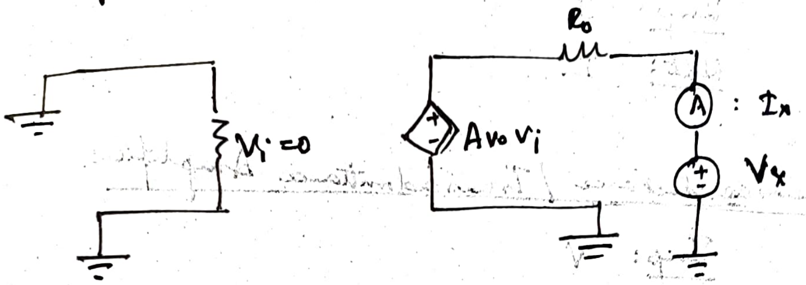


Transresistance

$R_i \to 0$

$R_o \to 0$

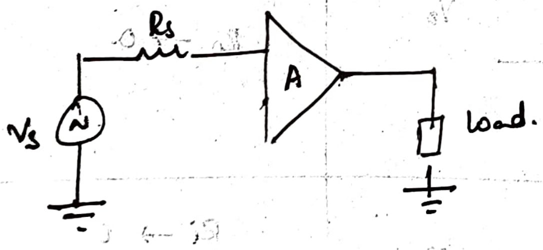
In a voltage amplifier, we can find the value of R_o by setting $v_i = 0$ and using a power source in output.



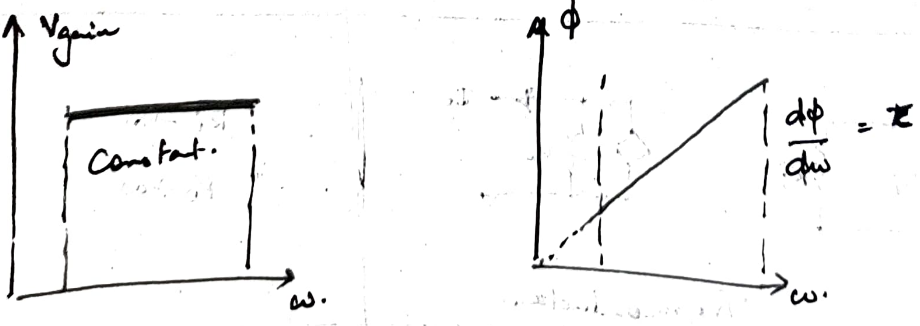
$$R_o = \frac{V_x}{I_x} \text{ at equilibrium.}$$

(. . . .)

Characteristic of Amplifier by Frequency Response:



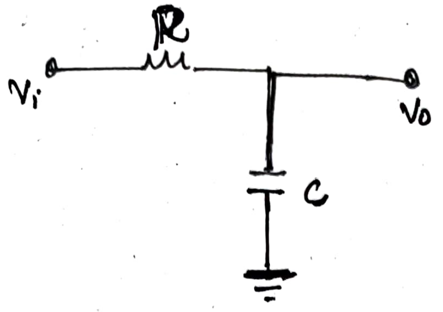
Bode plot: Plot of gain and phase response.



τ: delay b/c of amplification

the gain and delay because of linear amplifier is same for all frequencies.

Low-Pass filter:



When $\omega \to 0$

$X_C \to \infty.$

$\Rightarrow V_o \approx V_i$

When $\omega \to \infty$

$X_C \to 0$

$\Rightarrow V_o \to 0.$

$$\left|\frac{V_o}{V_i}\right| = \frac{|X_C|}{|X_C + R|} = \frac{(1/\omega C)}{\sqrt{R^2 + (1/\omega C)^2}} = \frac{1}{\sqrt{1 + (\omega/\omega_0)^2}}$$

where $\omega_0 = 1/RC.$

When $\omega \approx \omega_0$ $\quad \left|\frac{V_o}{V_i}\right| \approx \frac{1}{\sqrt{2}}$, in dB: -3dB.

When $\omega \approx 10\omega_0$ $\quad \left|\frac{V_o}{V_i}\right| = \frac{1}{10}$, " $= -20$dB.

Phase change:

$$\angle \frac{V_o}{V_i} = \angle \frac{1}{1 + j\frac{\omega}{\omega_0}} = -\tan^{-1}(\omega/\omega_0)$$

Bode plot: