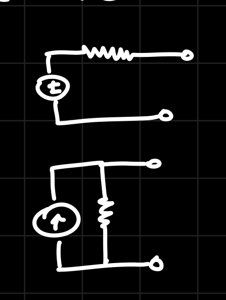
• lecture : 1

COURSE: Analog Electronics

⇒ Signals

→ contains info about of stuff in physical environment
  eg: Temp, Pressure, Heat, Audio etc.
→ Devices are used to extract info from the environment
→ Signals can be processed to achieve the desired results; eg: amplification / compression / ...
→ Processed using electronic circuits.
→ Physical signals must be identically converted into an electronic signal using TRANSDUCERS
  eg: microphones have pressure transducers
  seismic transducers used for animal movement by NFR in remote areas

Voltage SRC → Thevenin →
Current SRC → Norton →



waves
↳ Amplitude
↳ Frequency
↳ Phase

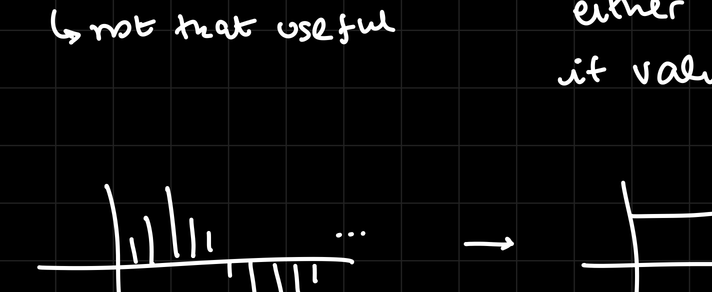
• FREQUENCY SPECTRUM OF SIGNALS

no. of frequencies in....
- sinusoidal signal → 1 at origin
- rectangular signal → very high
- sawtooth signal → very high

Sampling → convert from analog to discrete

digital vs discrete
- digital ↓ limited on the amplitude scale
- discrete ↓ no limit on the set of amplitude it can achieve

Two level quantizer → snaps the value to either 0/1 depending if value is low/high
↳ not that useful

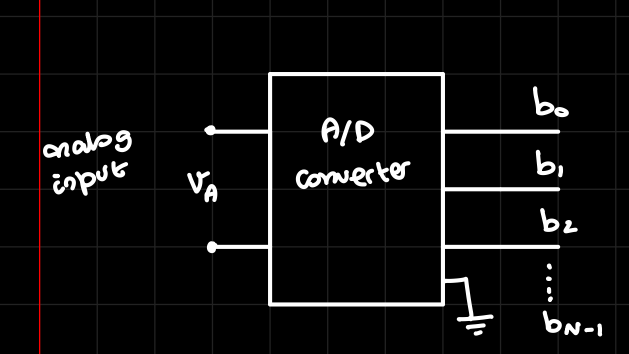


4 level quantizer → better resolution / precision

HD : higher quantization rate
(not necessarily related to sampling rate)
↙ more info per "packet"

expensive
↳ ckt design
↳ transportation from source to destination

Conversion happens using A/D converter
analog → digital



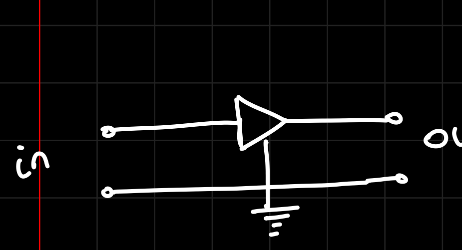
⇒ Amplification

Transdures operate at very low power ~10μV
Hence, the signal produced has a very low amplitude. Thats why amplifiers are needed.

LINEARITY : after amplification, no distortion should be introduced

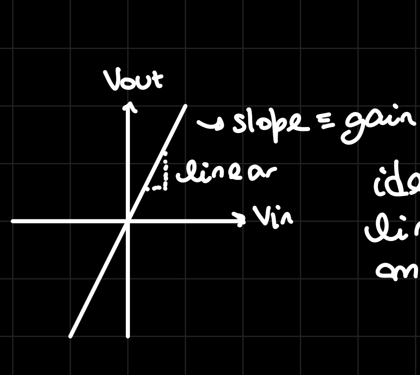
↳ not a good amplifier (non-linear)

* Two kind of Amps
↳ Voltage Amplifiers
↳ Current Amplifiers
} ⇒ we also have power amplifiers
↳ substantial current gain
↳ moderate voltage gain



• Voltage Gain (A_V)

$$A_V = \frac{V_o}{V_i}$$



• Current Gain (A_i)

$$A_i = \frac{i_o}{i_i}$$

• Power Gain (A_p)

$$A_p = \frac{V_o i_o}{V_i i_i} = A_V A_I$$

→ Gain in dB (logarithmic scale)

only two operations : add/subtract
easier to operate on larger values

Volt gain in dB = $20 \log_{10} \underbrace{|A_V|}_{\text{absolute value}}$ negative means phase shift signal hasn't attenuated

Current gain in dB = $20 \log_{10} |A_i|$

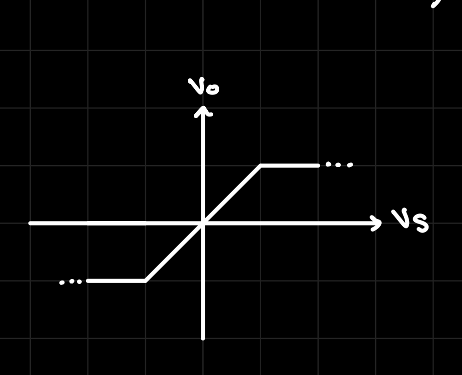
Power gain in dB = $10 \log_{10} |A_P|$

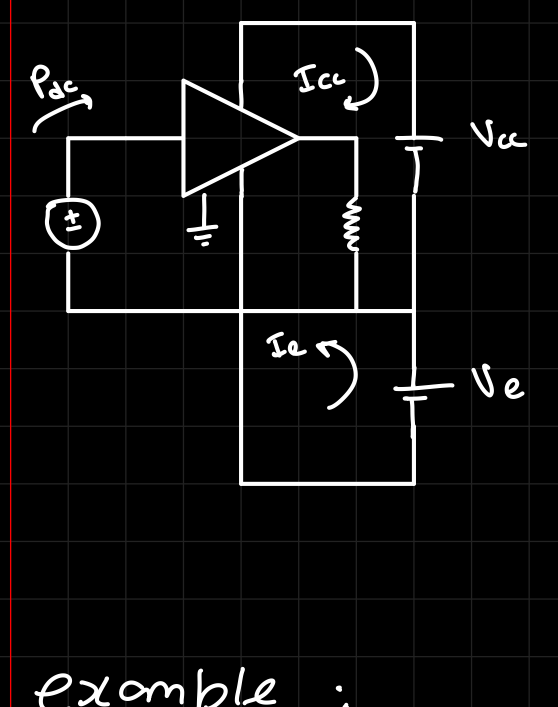
if you combine two phase shifted waves, it is destructive

⇒ Amplifier Power Supply

where are the extra signals coming from?
↳ DC Power Source
↳ decides the gain of the amplifier

Actual amplifiers do not provide ∞ amplification. There is some threshold which is allocated by the DC src (BIAS)





$$P = V_{cc} I_{cc} + V_e I_e$$

$$P_{dc} + P_i = P_L + P_{dissipated}$$

example :

$V_{cc} = V_{EE} = 10V$

$V_{I\,peak} = 1V$, $V_{RMS_I\,peak} = \frac{1}{\sqrt{2}} V$

$V_{o\,peak} = 9V$, $V_{RMS_o\,peak} = \frac{9}{\sqrt{2}} V$

$I_{cc} = I_{EE} = 9.5\,mA$

$R_L = 1k\Omega$

$i_{I\,peak} = 0.1\,mA$, $i_{RMS_I\,peak} = \frac{0.1}{\sqrt{2}} mA$

$P_i = 0.1\,mW$

$P_L = \frac{9}{\sqrt{2}} \times \frac{9}{\sqrt{2}} = \frac{81}{4} = 40.5\,mW$
↓
$V_o \times I_o$

Voltage gain : $A_V = \frac{9/\sqrt{2}}{1/\sqrt{2}} = 9 = 19.1\,dB$

Current gain : $A_i = \frac{V_o/R_L}{0.1} = \frac{9/1000}{0.1 \times 10^{-3}} = 90 = 39.08\,dB$

Power gain : $A_P = A_i \times A_V = 810 = 29.1\,dB$

Power drawn from dc src : $P_{dc} = 190\,mW$
↳ $V_{cc} I_{cc} + V_{EE} I_{EE}$

Power dissipated in amp: $P_{diss} = P_L - P_i - P_{dc}$
$= 149.5\,mW$

efficiency $= \frac{P_L}{P_{dc}} \times 100 = 23.1\%$

→ Amplifier saturation

Signal clipping : if amp not designed properly
↓
Amp error