

DIFFERENTIAL AMPLIFIER

ELECTRONIC CIRCUITS-I

Course Instructor (Elex. SECTION A)

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Course Homepage:

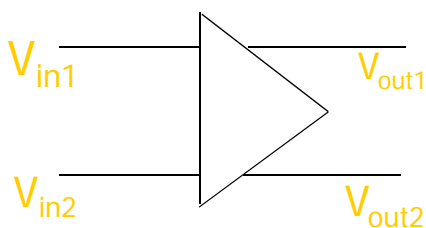
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INTRODUCTION

DIFFERENTIAL AMPLIFIER



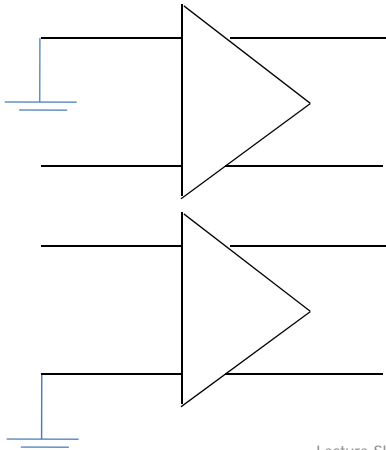
Definition:

- A circuit that amplifies the **voltage difference** between **two input signals**. The instantaneous output voltage is equal to some constant multiple of the difference between the instantaneous input voltages.

i.e. **Output = Constant** ($V_{in1} - V_{in2}$)

TERMINOLOGIES OF DIFF. AMP

Single Ended Input



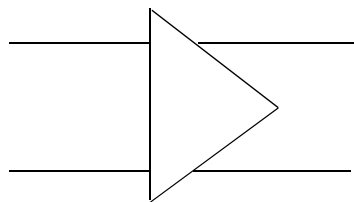
- A **single ended** input configuration is the one in which **one** of the input is grounded.
- Note that this has **no** relation with the single ended gain obtained in the lab.

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TERMINOLOGIES OF DIFF. AMP (CONTD.....)

Double Ended Input



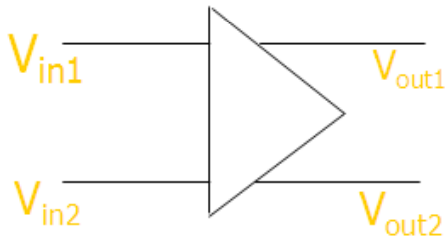
- A **double ended input** configuration is the one in which **neither** of the inputs are grounded.
- A **double ended circuit** is a symmetrical circuit (i.e., one having identical halves)

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TERMINOLOGIES (CONTD...)

Single Ended Output



- Whenever one output is taken w.r.t. **ground**, the output is said to be **single ended** and unbalanced.

- i.e. $V_{out} = (V_{out1} - 0)$

$$= V_{out1}$$

OR

$$V_{out} = (V_{out2} - 0)$$

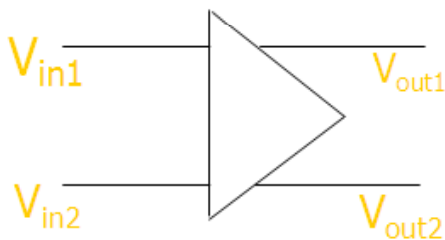
$$= V_{out2}$$

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TERMINOLOGIES (CONTD...)

Double Ended Output



- Whenever the output is taken w.r.t. **another output**, the output is said to be **double ended** and balanced.

- i.e. $V_{out} = (V_{out1} - V_{out2})$

OR

$$V_{out} = (V_{out2} - V_{out1})$$

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TERMINOLOGIES (CONTD...)

Common Mode Rejection Ratio

- Ratio between Differential Mode gain to Common mode gain
- Ideally, the common mode gain should be zero
- Mathematically,
- Ideally, CMRR is infinite

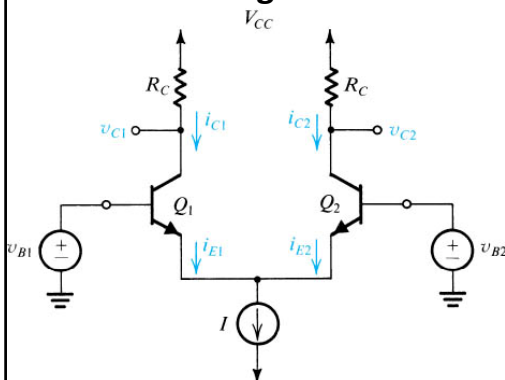
$$\text{CMRR} = \frac{A_d}{A_c}$$

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BJT DIFFERENTIAL AMPLIFIER

• Circuit Diagram



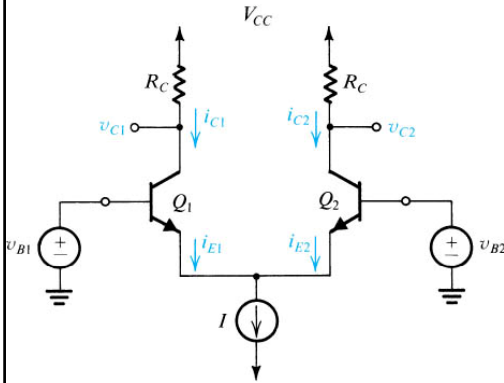
- Why a constant current source ?
 - As a long tailed pair (LTP) configuration, the diff. amp requires a high resistance on it's emitter side.
 - Current source:- Very high resistance
 - High resistance:- low common mode gain & high CMRR

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BJT DIFFERENTIAL AMPLIFIER (CONTD...)

Simulation Results



Simulation A

$v_{B1} = +50\text{mv}$ (Peak)

$v_{B2} = 0$ (grounded)

$v_{C1} = -4.14\text{ V}$ (Peak)

$v_{C2} = +4.13\text{ V}$ (Peak)

Simulation B

$v_{B1} = 0$ (grounded)

$v_{B2} = +50\text{mv}$ (Peak)

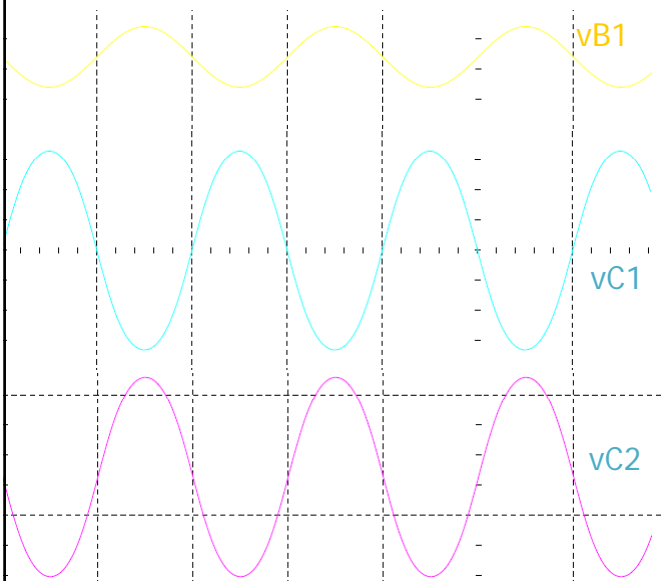
$v_{C1} = +4.13\text{ V}$ (Peak)

$v_{C2} = -4.14\text{ V}$ (Peak)

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WAVEFORMS (Simulation A)



• v_{B1} is the inverting input to

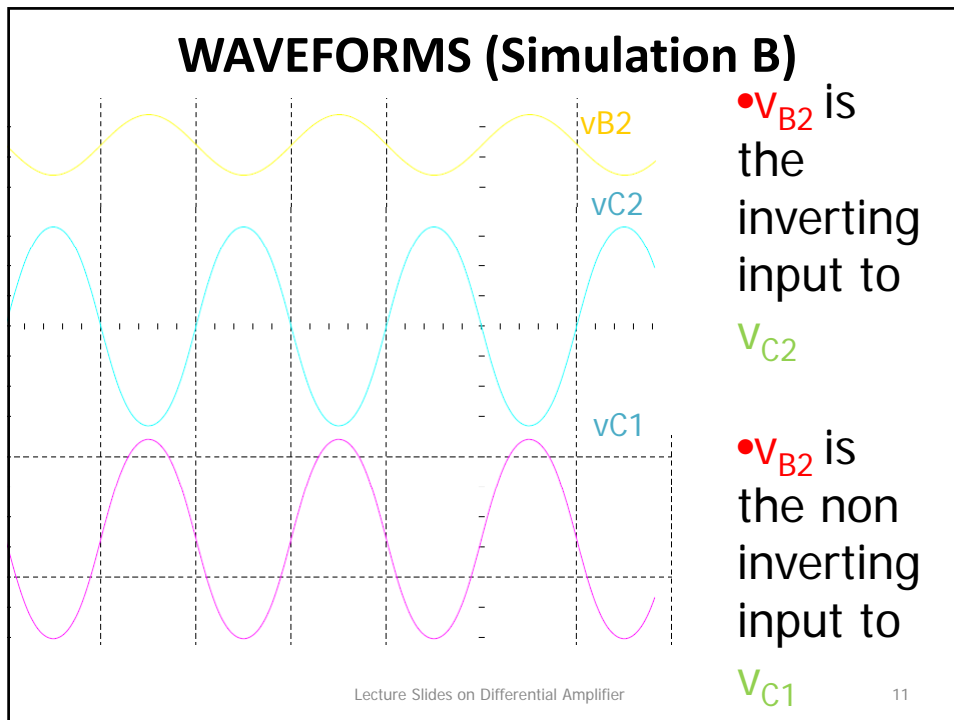
v_{C1}

• v_{B2} is the non inverting input to

v_{C2}

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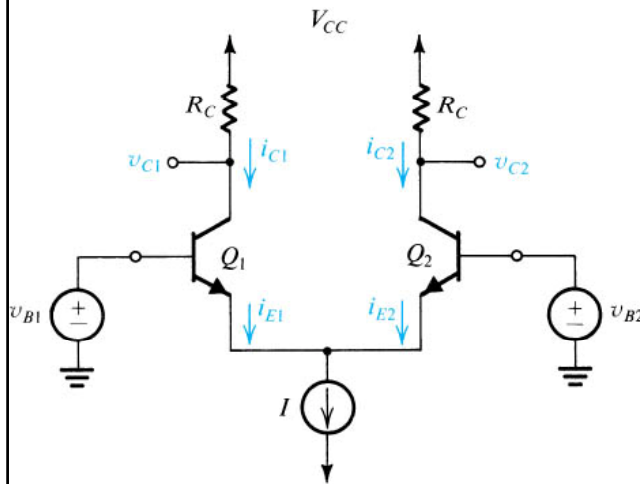
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Inverting & non-inverting inputs

- **Inverting input**
 - the input circuit that *produces a phase reversal* between the input and output in a differential amplifier or an operational amplifier
- **Non-inverting input**
 - the input circuit that provides an output signal *in phase with the input* in a differential or operational amplifier

BJT diff. Amp. (Contd...)



- For v_{B2} grounded
- Q1 acts as common emitter amp.
- Q2 acts as emitter follower
- For v_{B1} grounded it's the opposite

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Derivations

- Prove that the output of the differential amplifier is proportional to the two input signals.
- Derive the output resistance of a BJT differential amplifier.

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