SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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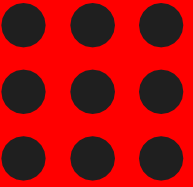
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 19EE101-BASIC ELECTRICAL & ELECTRONICS ENGINEERING
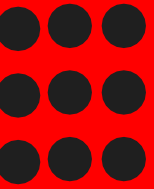
I YEAR /I SEMESTER

Unit 5: Linear and Digital Electronics

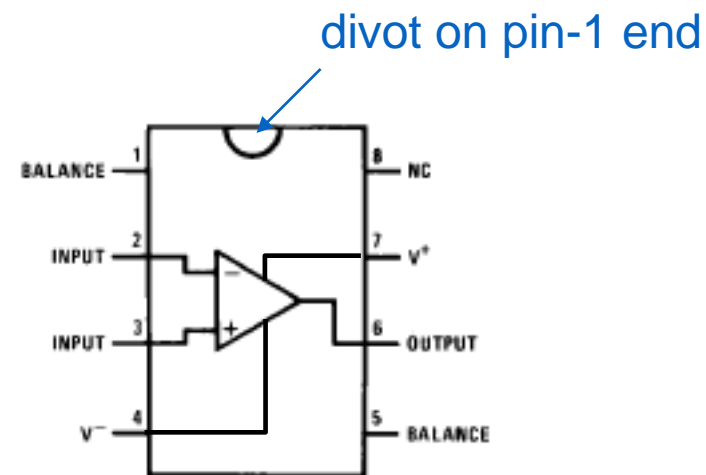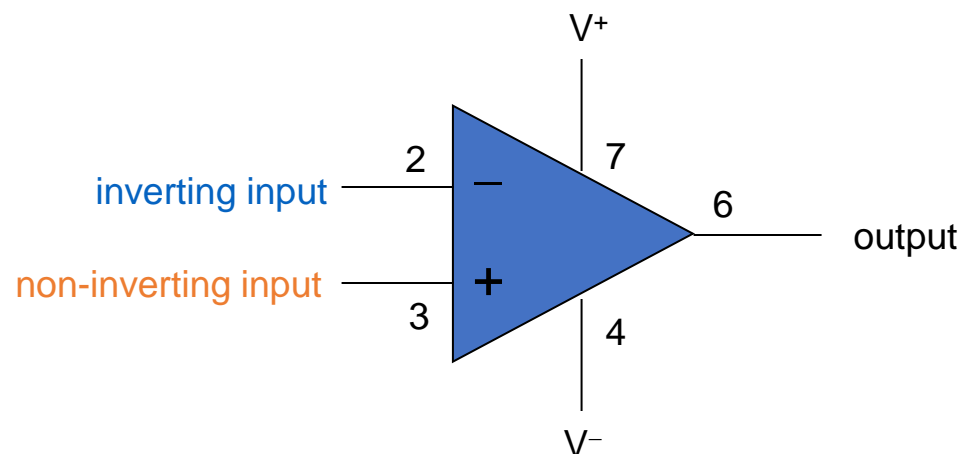Topic : Introduction to Operational Amplifier

GRADUATE ATTRIBUTES

OPERATIONAL AMPLIFIER

- Op-amps (amplifiers/buffers in general) are drawn as a triangle in a circuit schematic

- There are two inputs
  - inverting and non-inverting

- And one output

- Also power connections (note no explicit ground)

OPERATIONAL AMPLIFIER

- Infinite voltage gain
  - a voltage difference at the two inputs is magnified infinitely
  - in truth, something like 200,000 means difference between + terminal and – terminal is amplified by 200,000!

- Infinite input impedance
  - no current flows into inputs
  - in truth, about 10^{12} Ω for FET input op-amps

- Zero output impedance
  - rock-solid independent of load
  - roughly true up to current maximum (usually 5–25 mA)

- Infinitely fast (infinite bandwidth)
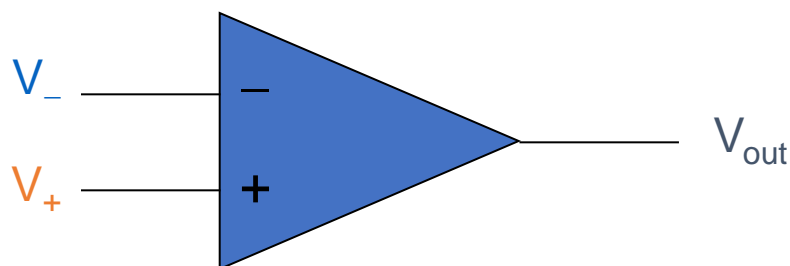 - in truth, limited to few MHz range
  - slew rate limited to 0.5–20 V/μs
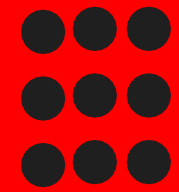
- The internal op-amp formula is:

$$V_{out} = gain \times (V_+ - V_-)$$

- So if V_+ is greater than V_-, the output goes positive

- If V_- is greater than V_+, the output goes negative

- A gain of 200,000 makes this device (as illustrated here) practically useless

OPERATIONAL AMPLIFIER WITH NEGATIVE FEEDBACK

- Infinite gain would be useless except in the self-regulated negative feedback regime
  - negative feedback seems bad, and positive good—but in electronics positive feedback means runaway or oscillation, and negative feedback leads to stability

- Imagine hooking the output to the inverting terminal:

- If the output is less than V_{in}, it shoots positive

- If the output is greater than V_{in}, it shoots negative
  - result is that output quickly forces itself to be exactly V_{in}

negative feedback loop

V_{in}
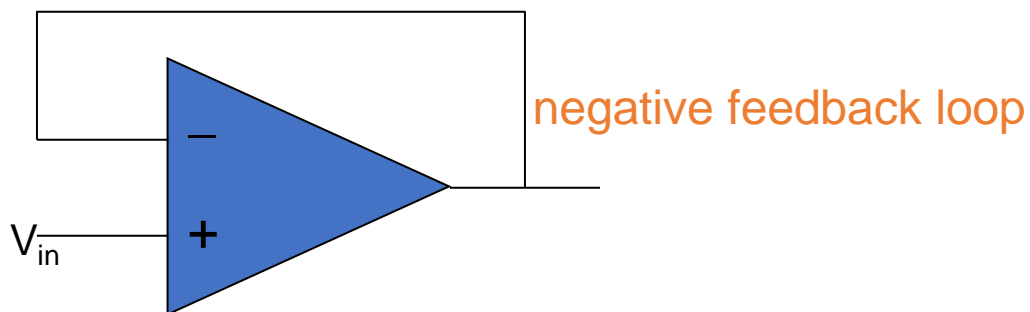
OPERATIONAL AMPLIFIER

- In the configuration below, if the + input is even a smidge higher than V_{in}, the output goes way positive

- This makes the + terminal even *more* positive than V_{in}, making the situation worse

- This system will immediately "rail" at the supply voltage
  - could rail either direction, depending on initial offset

V_{in}

positive feedback: BAD
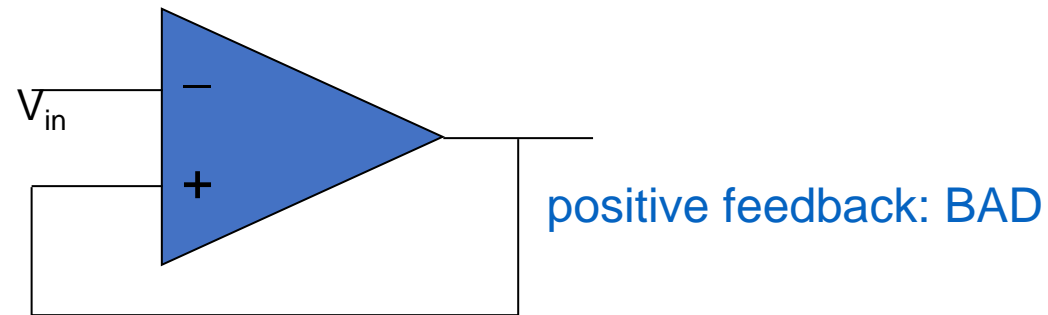
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3. Mehta V K, Mehta Rohit, "Principles of Electrical Engineering and Electronics", S.Chand & Company Ltd, (2010)- UNIT I and II

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THANK YOU