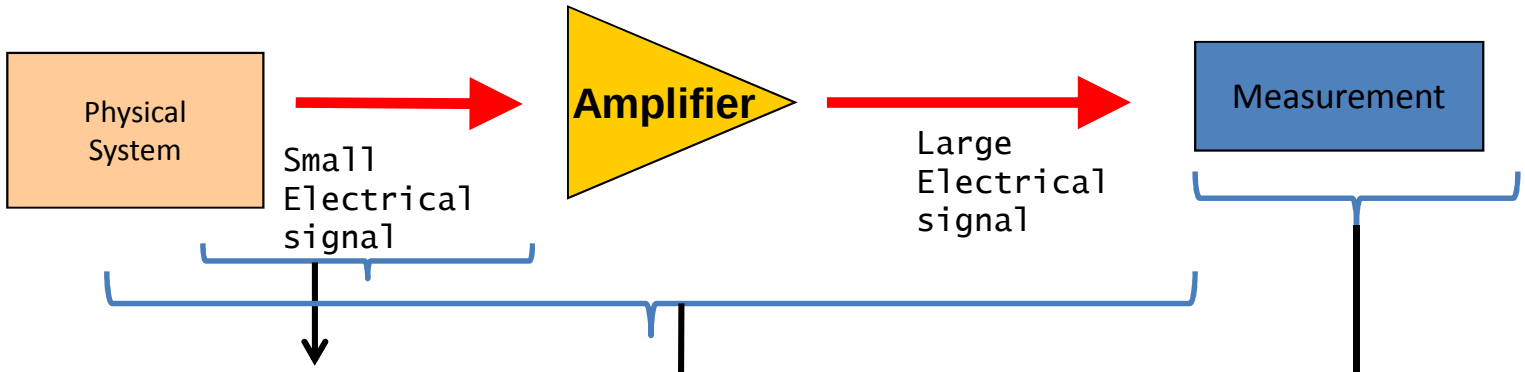
EP212
Electronics Lab 2
Analog Electronics
Lecture 1
Review, and plan for this semester

Electronics for Physicists – the big picture



<u>Electronics Lab – 1 (EP215) *last semester*</u>

Basic concepts (grounds, signal measurements)

Discrete BJT Amplifier designs (Voltage – CE, Current – Follower)

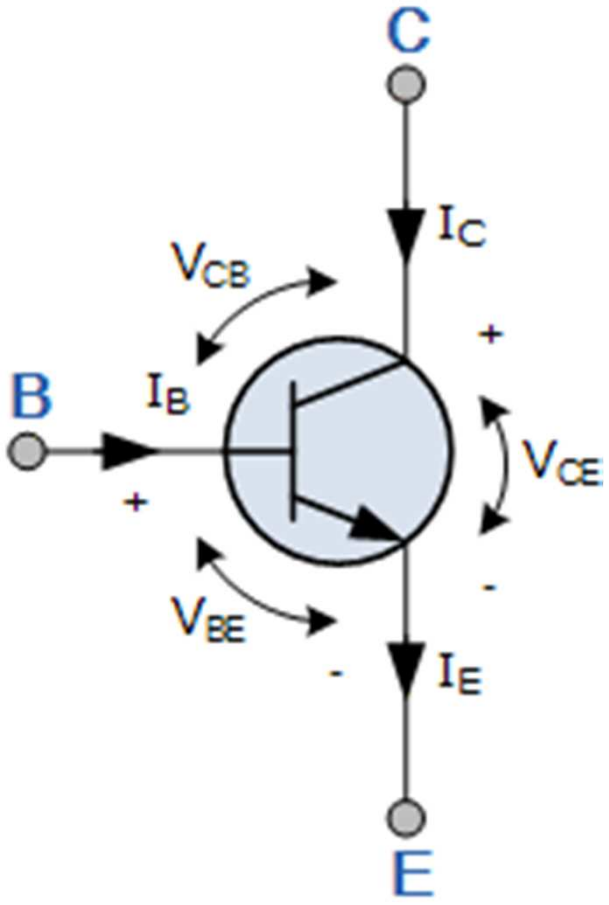
<u>Electronics Lab – 2 (EP212) *this semester*</u>

- Operational Amplifiers (opamps)
- Feedback
- Signal measurement in presence of noise

<u>Electronics Lab – 3+4 (EP315 + EP317) *next semester*</u>

- Digital measurement and control systems

Recall BJT transistors from Electronics Lab -1



Symbol with voltages

3 terminal
ACTIVE device

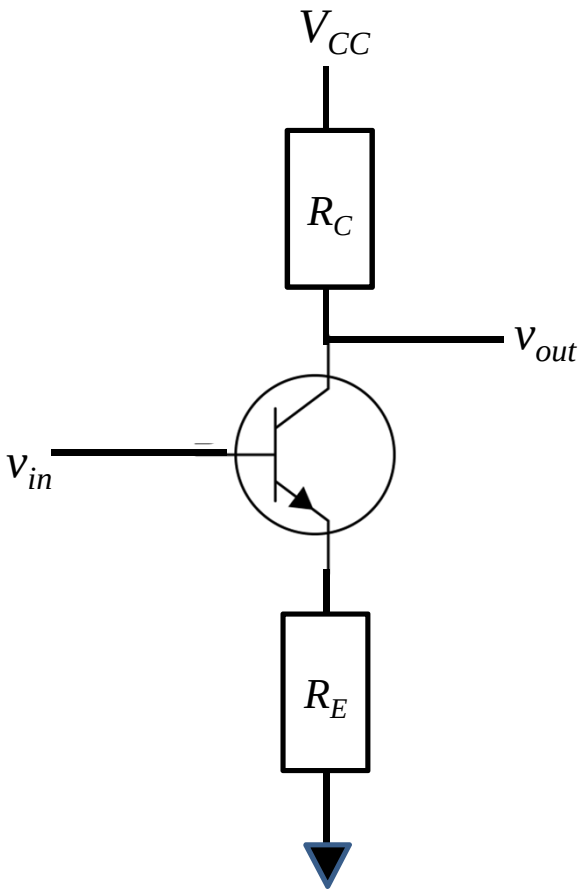
$$I_C = \beta I_B$$

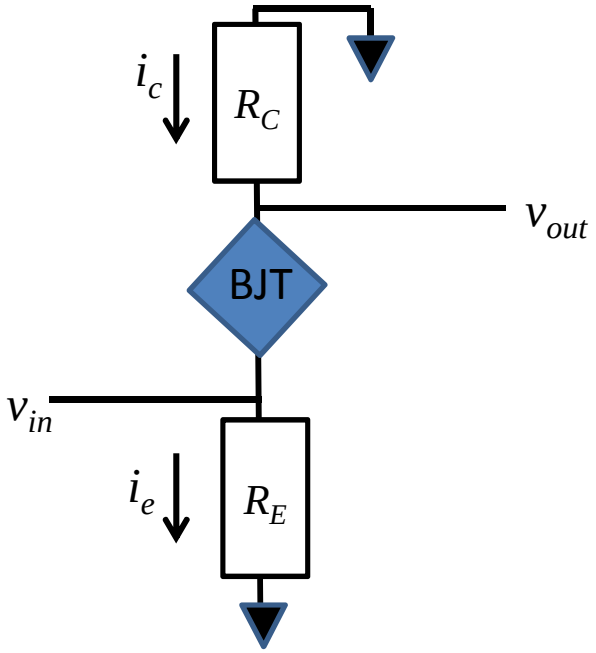
$$I_E \sim I_C$$

$$I_B \sim \mu A \; ; \; I_C \sim mA$$

$$r_e = 25mV / I_C$$

How does the transistor amplify?

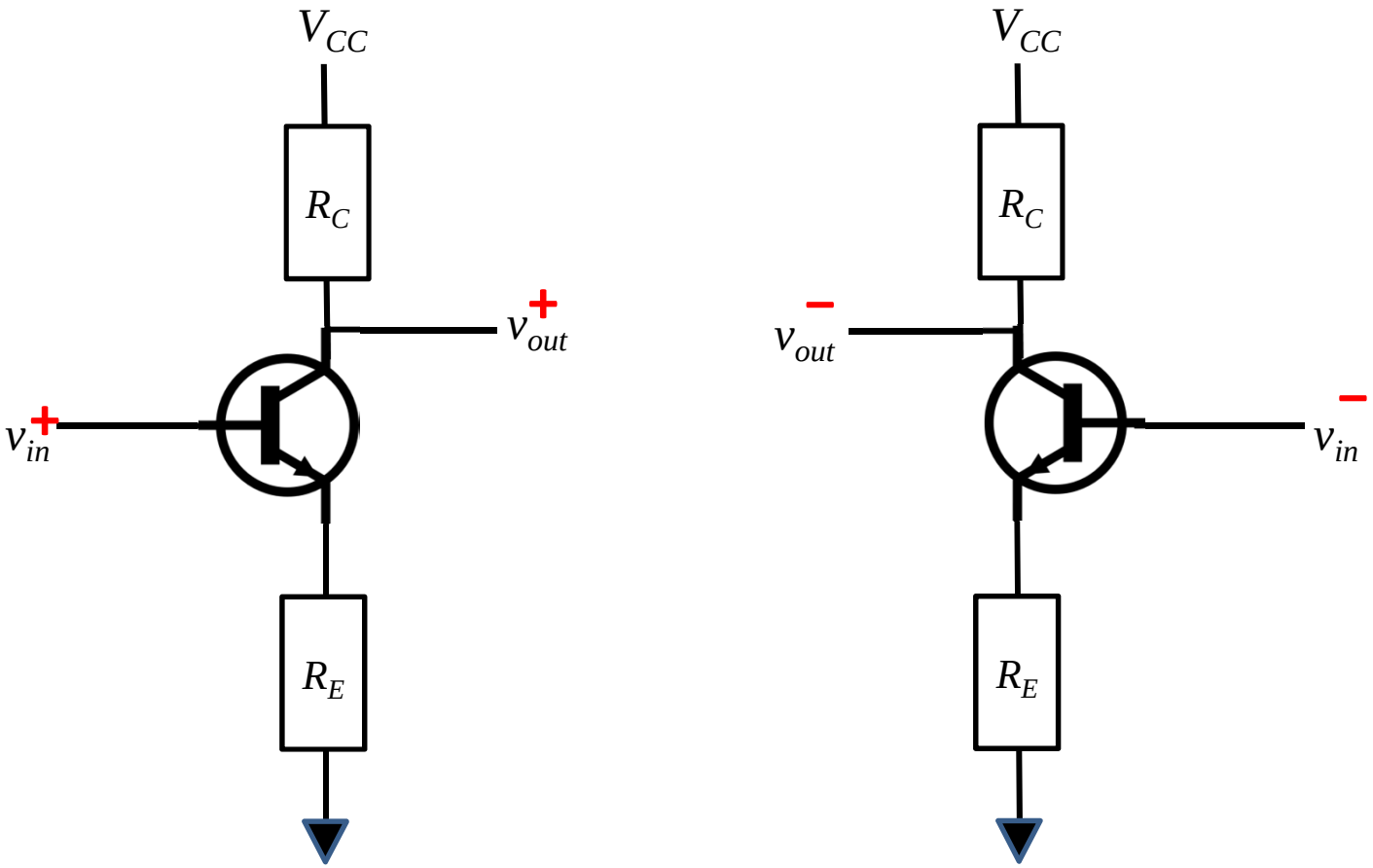




$$v_{out} = -i_c R_C$$
$$v_{in} = i_e R_E$$

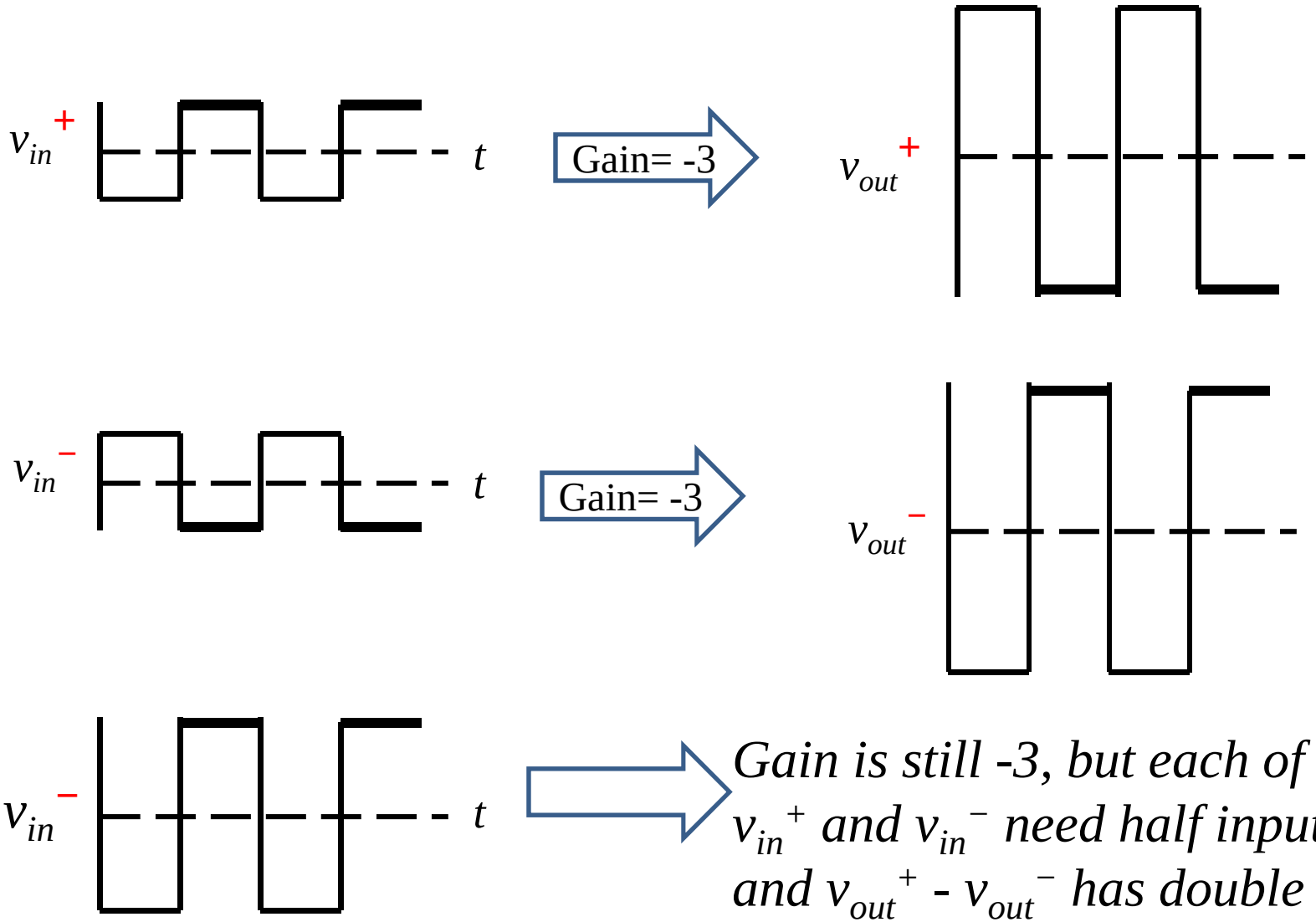
$$Gain = -R_C/R_E$$

How do **TWO** transistors work?

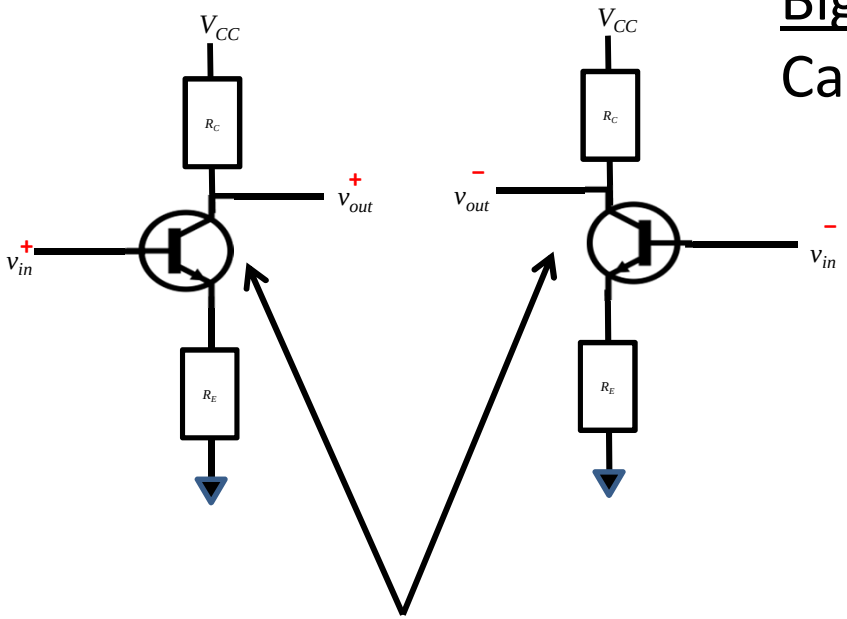


Note: Biasing details not shown

Differential signals are **GOOD**



What are the constraints of differential operation?



Big advantage:

Can DC-couple $v_{in} = (v_+ - v_-)$ at input

Transistors must be *exactly* matched

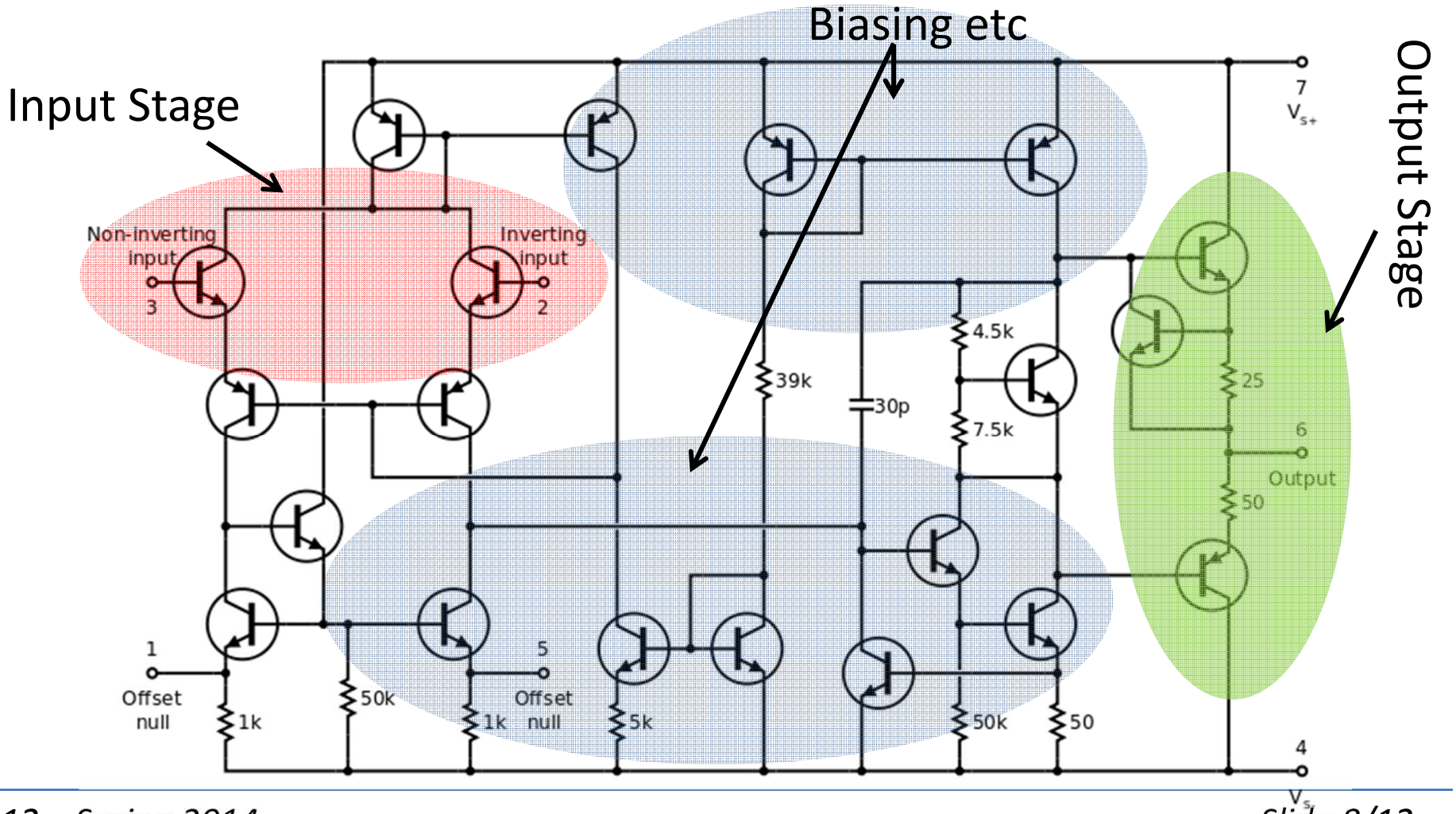
Resistors must be *exactly* matched

Wires must be *exactly* matched

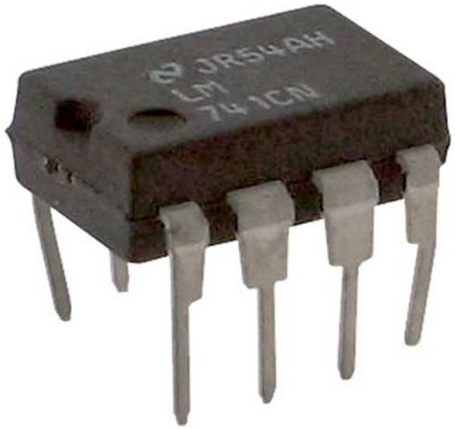
Later stages (V→I) must be *exactly* matched

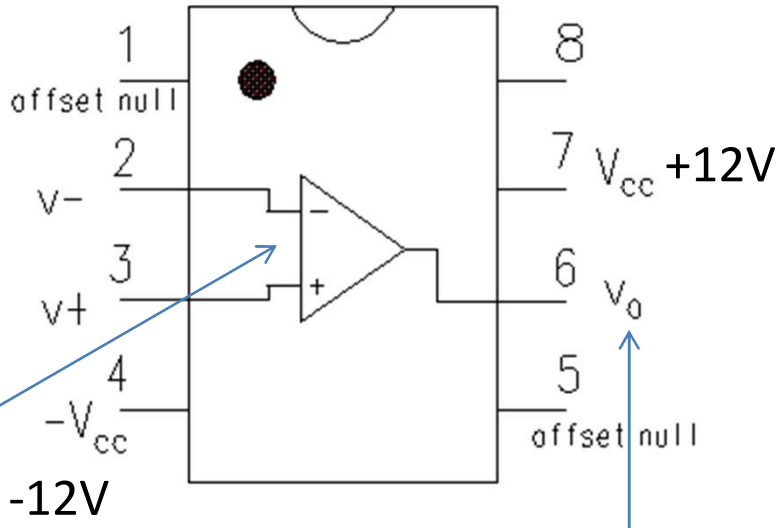
Bureau of component matching

OpAmp integrates precision matched actives+passives in one IC



Your friend for Spring 2014
LM741 OpAmp IC





Close to zero input current (high input impedance)

Current drive output (low output impedance)

Close to infinite open loop gain

OPAMP ≡ DC coupled high gain amplifier

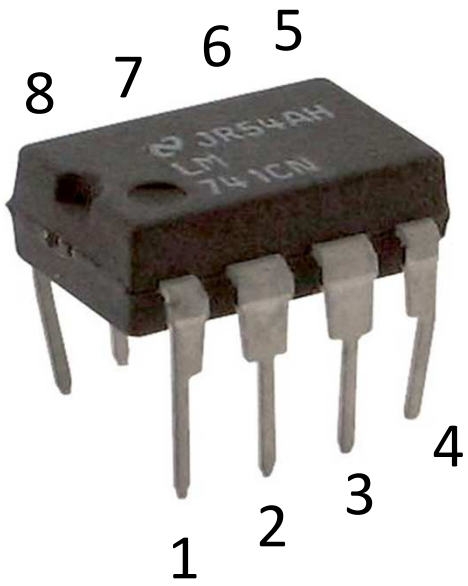
Preparation for Lab 1

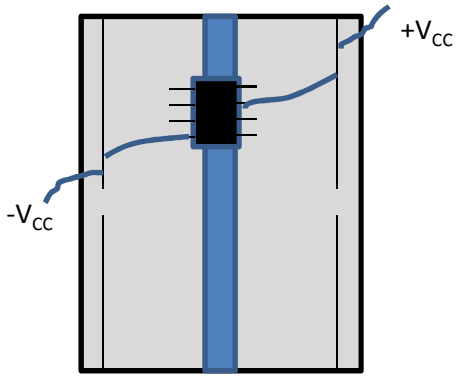
Treat your friend with love and affection!

Don’t bend the IC pins when inserting into breadboard

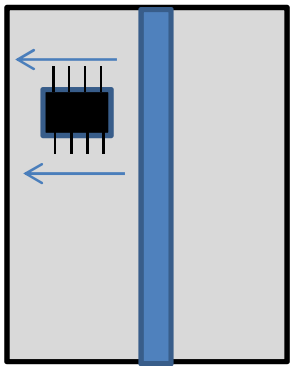
Remember the notch

- pin numbers start at the notch
- You must always use dual voltage supply
  $+V_{CC}$(to pin 7) and $-V_{CC}$(to pin 4) $|V_{CC}| < 20V$





CORRECT: Each pin has a separate breadboard trace. $+V_{CC}$ and $-V_{CC}$ are connected along the edge traces



WRONG ! Pins 1-4 and 5-8 are shorted to each other

Course Reference

The OpAmp cookbook
by
Walt Jung

Available open-source online from many sites
(eg) Analog Devices “Analog Dialogue”