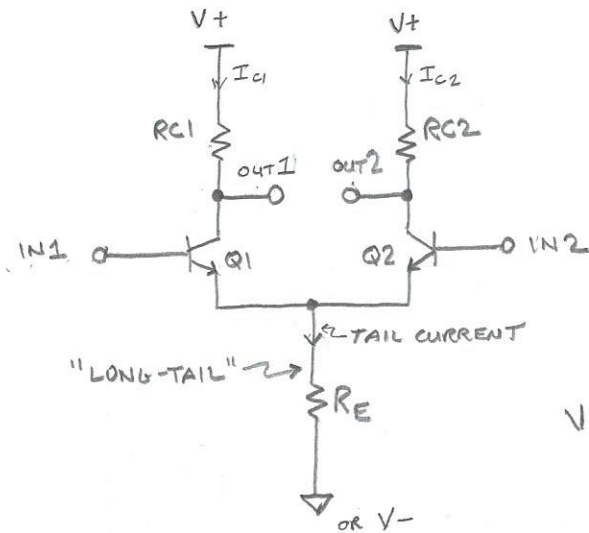


BACK TO BASICS:

THE DIFFERENTIAL AMPLIFIER

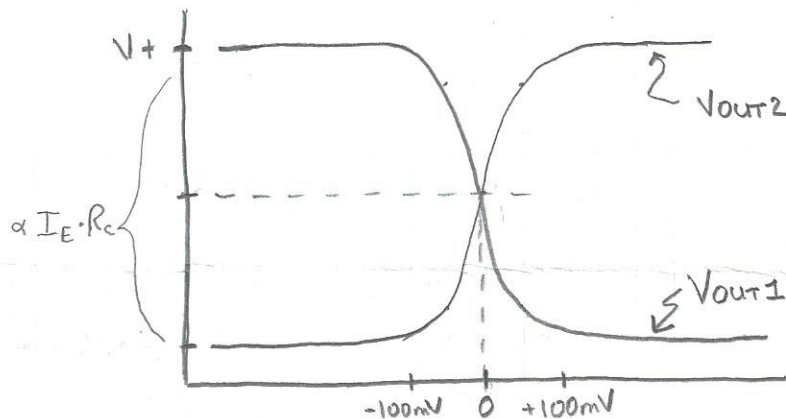
A.K.A. LONG-TAILED PAIR, EMITTER COUPLED PAIR



- BASIC CHARACTERISTICS
- SMALL SIGNAL BEHAVIOR
- LARGE SIGNAL BEHAVIOR
- CURRENT SOURCES CAN HELP!!!

WHEN $V_{IN1} = V_{IN2}$:

- TAIL CURRENT SPLITS EQUALLY B/T Q1+Q2
- $I_{C1} = I_{C2}$
- $V_{out1} = V_{out2}$



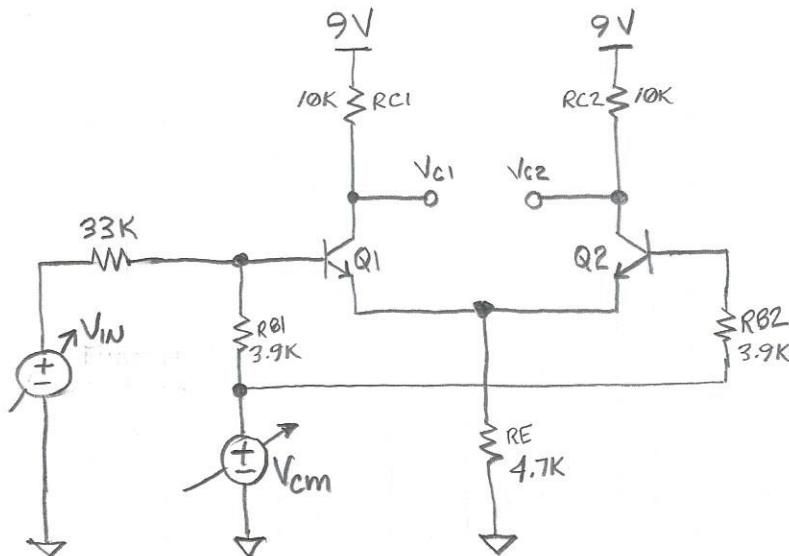
$$g_m = \frac{I_c}{V_T}$$

$$V_T = 26mV$$

$$A_D = g_m R_c$$

$$A_{S.E.} = \frac{g_m R_c}{2}$$

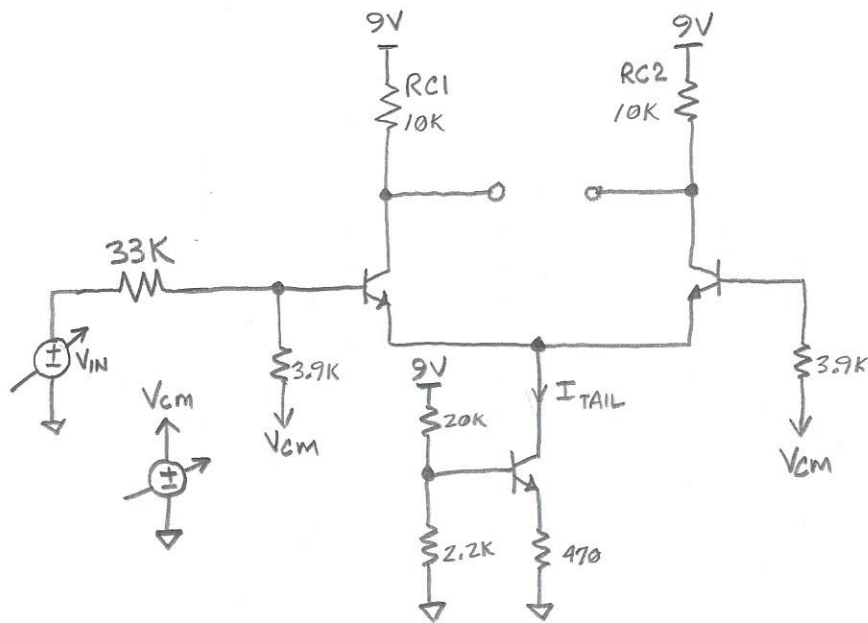
TEST CIRCUIT



"IMPERFECT" BEHAVIOR:

- COMMON MODE SIGNAL IS AMPLIFIED
- DIFFERENTIAL GAIN IS A FUNCTION OF COMMON MODE VOLTAGE

CURRENT SOURCE TO THE RESCUE!

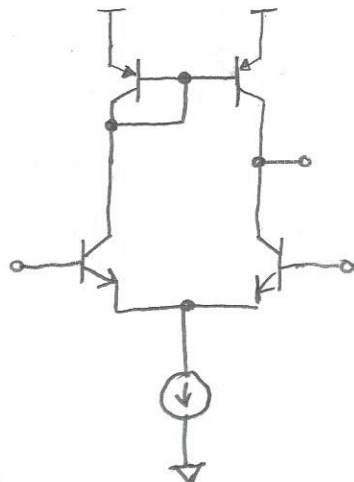


- REPLACE R_E WITH A CURRENT SOURCE
- I_{TAIL} IS CONSTANT VS. COMMON MODE VOLTAGE
- OUTPUT IS NEARLY UNAFFECTED BY COMMON MODE VOLTAGE

GOOD COMMON-MODE REJECTION!

- DIFFERENTIAL GAIN IS NOT AFFECTED BY COMMON MODE

(SINGLE-ENDED GAIN TOO!)



- REPLACE LOAD RESISTORS WITH A CURRENT MIRROR

- SINGLE-ENDED OUTPUT
- GAIN IS MUCH HIGHER