



# **SNS COLLEGE OF TECHNOLOGY**

Kurumbapalayam (Po), Coimbatore – 641 107

**An Autonomous Institution**

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

**COURSE NAME : 19EC201-ANALOG ELECTRONIC CIRCUITS**

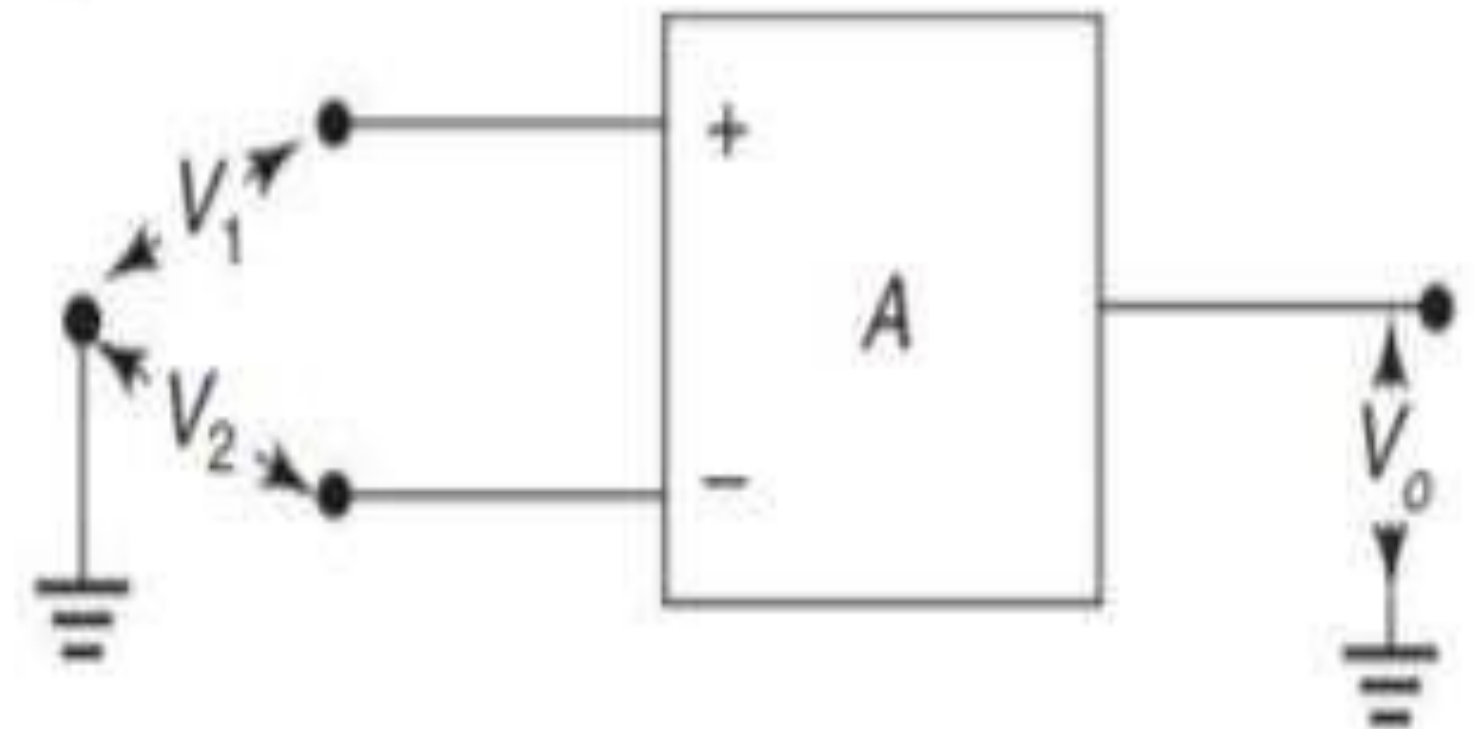
Topic : Differential Amplifiers



# Differential Amplifiers



- The function of a differential amplifier is to amplify the difference between two signals.
- The basic block diagram of a differential amplifier consists of two input terminals and one output terminal.





# Differential Amplifiers

- The output signal in a differential amplifier is proportional to the difference between the two input signals.

$$V_o = A_d (V_1 - V_2)$$

- If  $V_1 = V_2$ , the output voltage is zero.
- A non-zero output voltage is obtained if  $V_1$  and  $V_2$  are not equal



# Differential Amplifiers



- The difference-mode input voltage is defined as

$$V_d = (V_1 - V_2)$$

- The common-mode input voltage is defined as

$$V_{cm} = \frac{(V_1 + V_2)}{2}$$



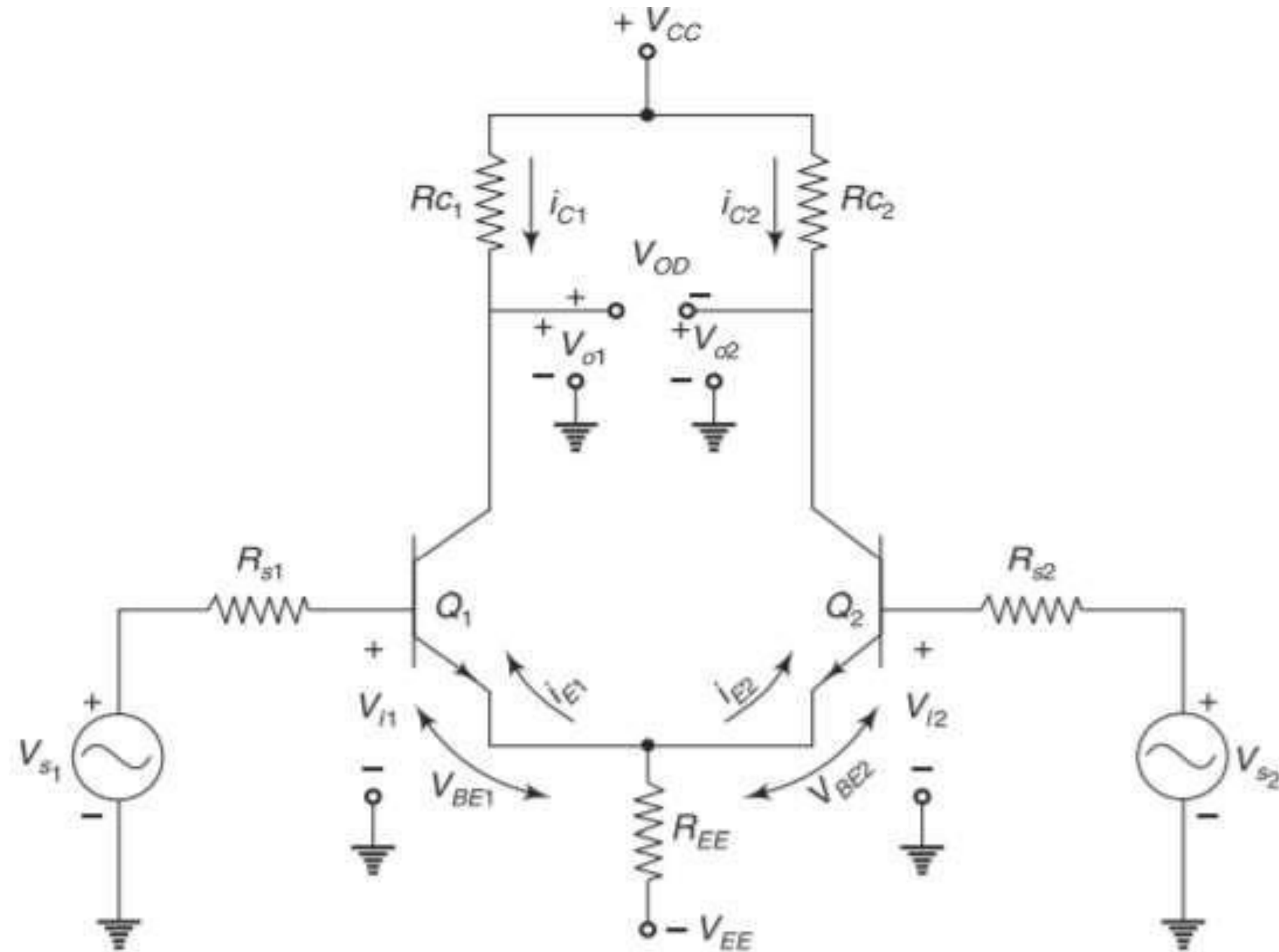
# Differential Amplifiers



- A differential mode amplifier has two modes of operations
- They are
- Differential mode operation
- Common mode operation



# Differential Mode Operation







# Differential Mode Operation



$$V_{out} \propto (V_1 - V_2)$$

$$V_{out} \propto V_d$$

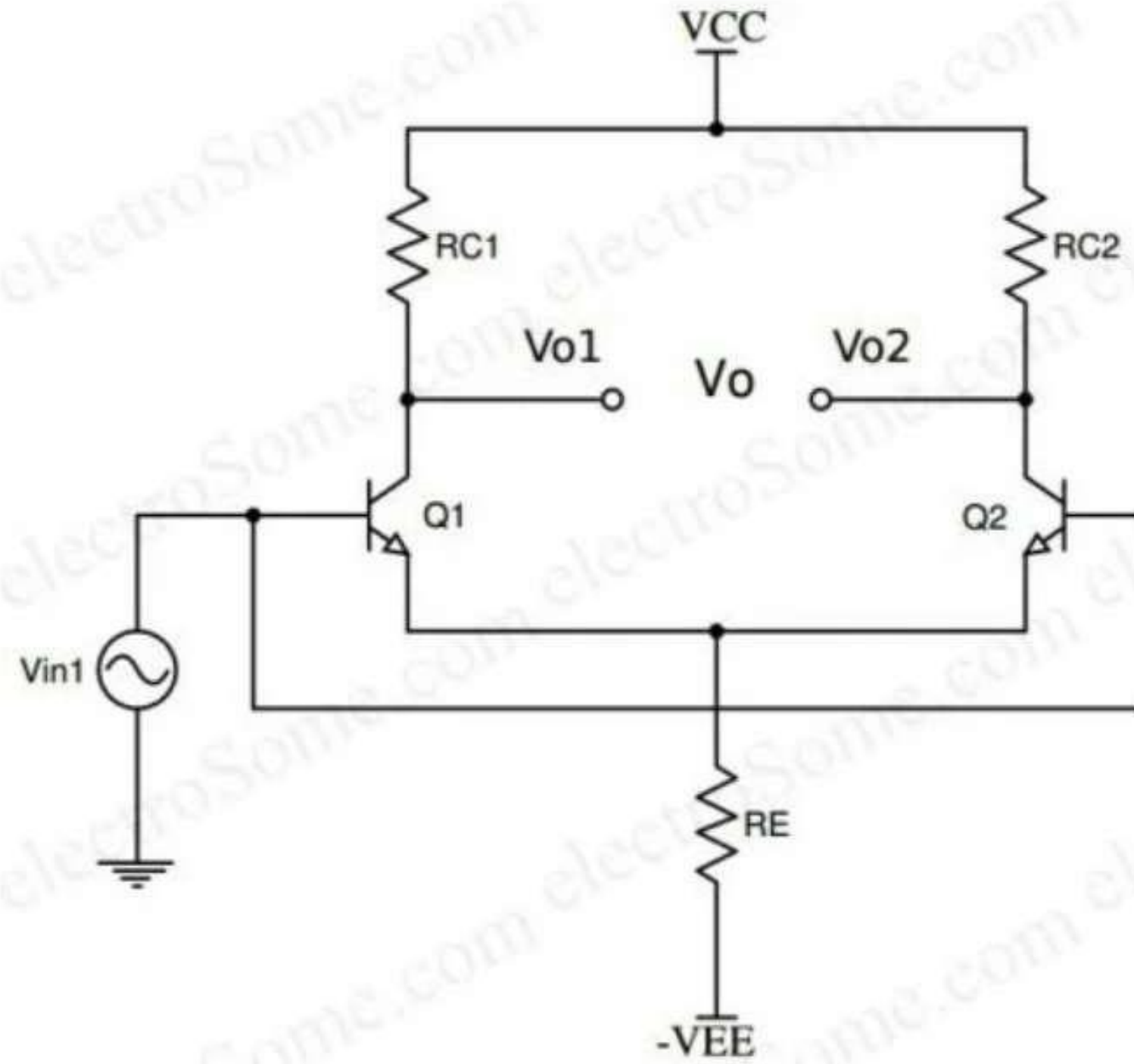
$$V_{out} = A_d V_d$$

$$A_d = \frac{V_{out}}{V_d}$$

$$V_d = V_1 - V_2$$



# Common Mode Operation







## Common Mode Operation

- A differential amplifier is said to be in common mode when same signal is applied to both inputs and the expected output will be zero, ie ideally common mode gain is zero.

$$V_c = \frac{V_1 + V_2}{2}$$

$$A_c = \frac{V_o}{V_c}$$



# Common Mode Rejection Ratio (CMRR)



- CMRR is introduced to define the ability of a differential amplifier to reject common mode signal.
- CMRR is defined as the ratio of the differential voltage gain  $A_d$  to common mode gain  $A_c$  and is generally expressed in dB.

$$\text{CMRR} = 20 \log_{10} \left| \frac{A_d}{A_c} \right|$$



# Features of Differential Amplifier



- High differential voltage gain
- Low common mode gain
- High CMRR
- High Input impedance
- Large bandwidth
- Low output impedance



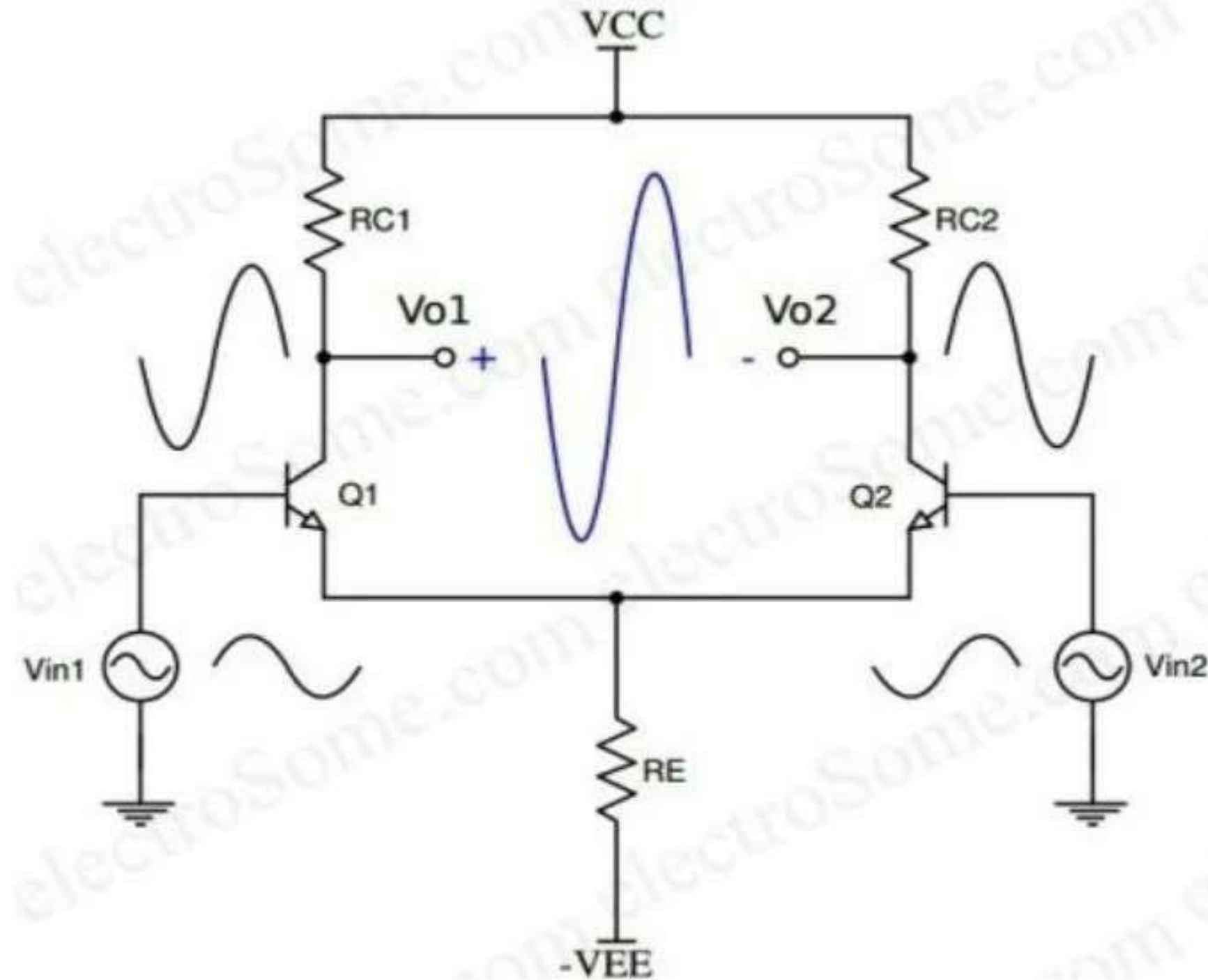
# Differential Amplifier Types



- Dual input, balanced output differential amplifier
- Dual input, unbalanced output differential amplifier
- Single input balanced output differential amplifier
- Single input unbalanced output differential amplifier

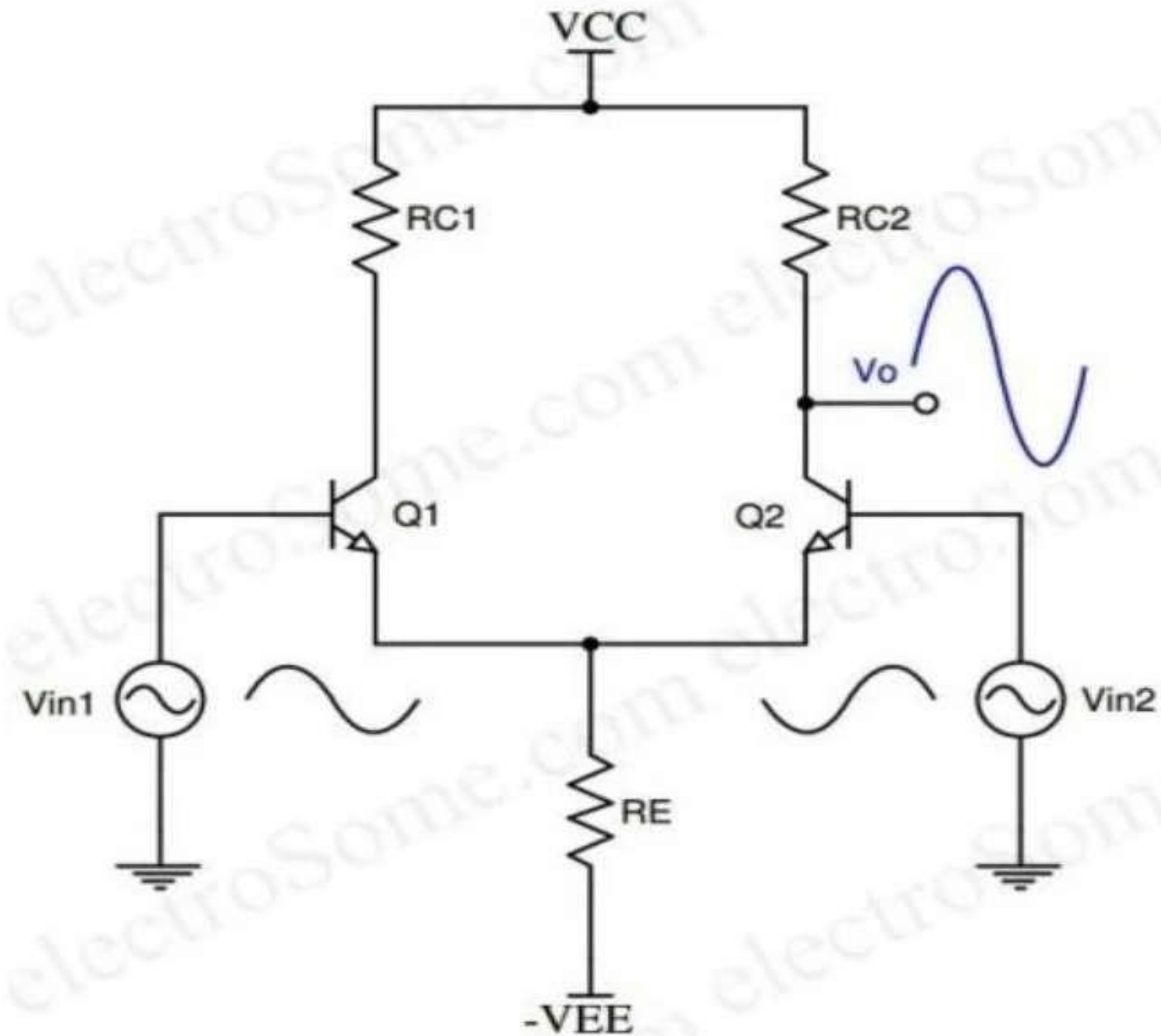


# Dual input, balanced output differential amplifier





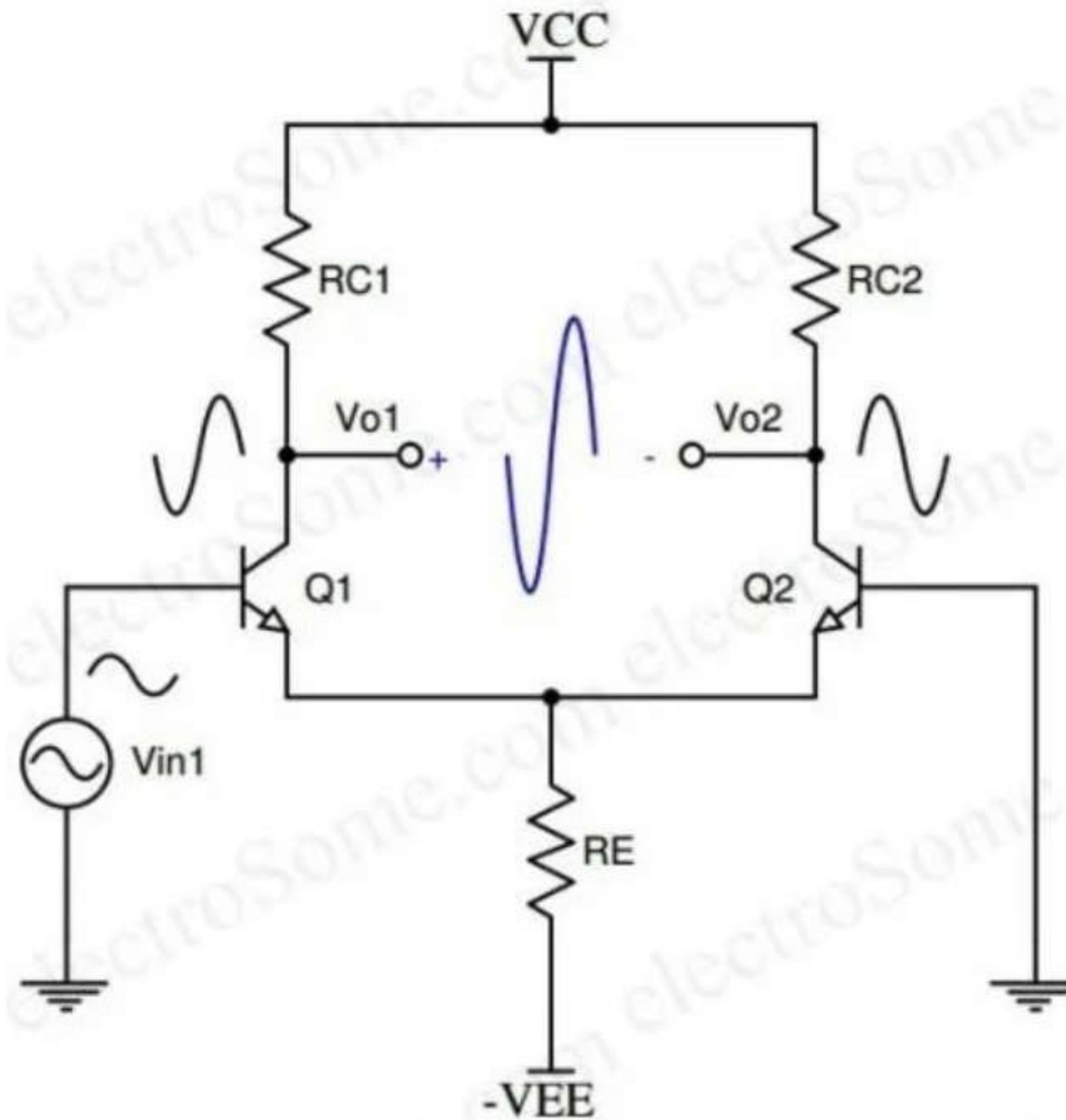
# Dual input, unbalanced output differential amplifier





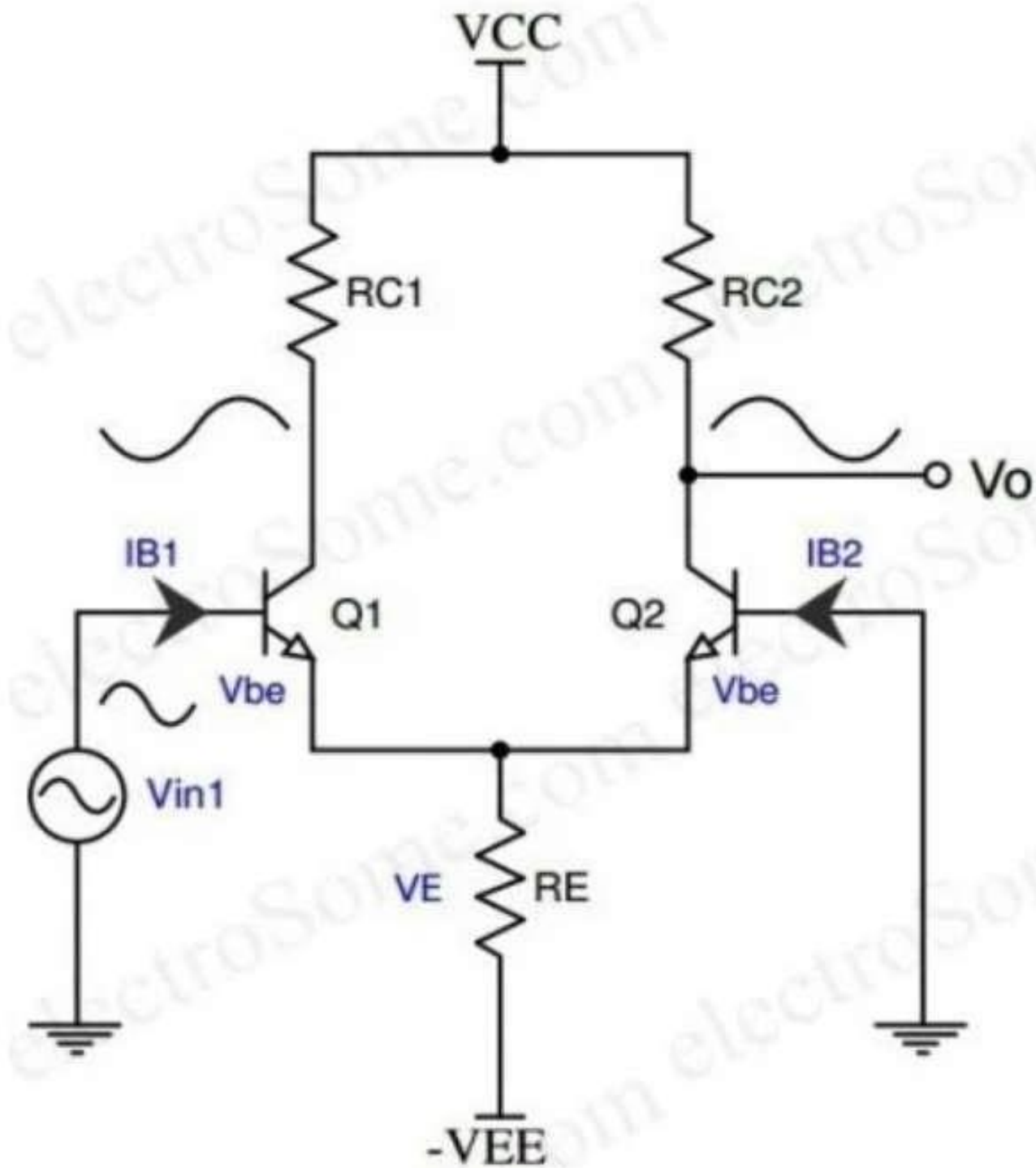


# Single input balanced output differential amplifier





# Single input unbalanced output differential amplifier





# Single input unbalanced output differential amplifier



THANK YOU