SNS COLLEGE OF TECHNOLOGY

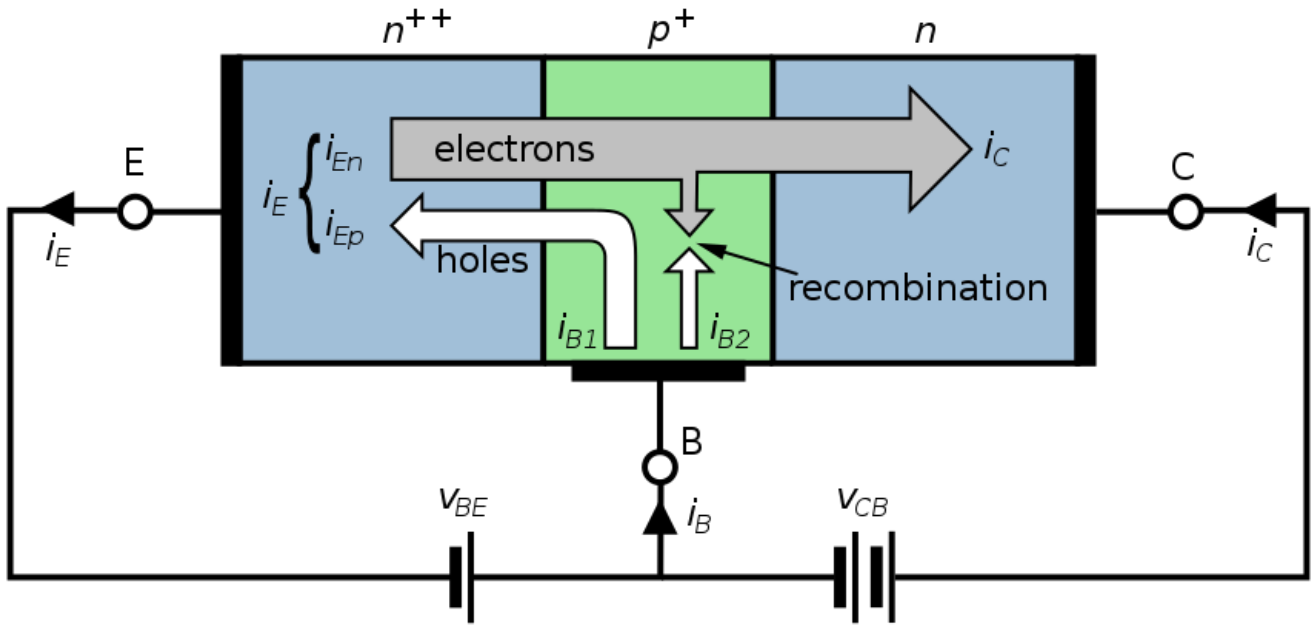
(An Autonomous Institution)
COIMBATORE-35
Accredited by NBA-AICTE and Accredited by NAAC – UGC with A+ Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

23EET104 / ANALOG ELECTRONICS CIRCUITS
I YEAR / II SEMESTER

UNIT-IV: DIFFERENTIAL AMPLIFIER AND MULTIVIBRATOR

DIFFERENTIAL AMPLIFIER

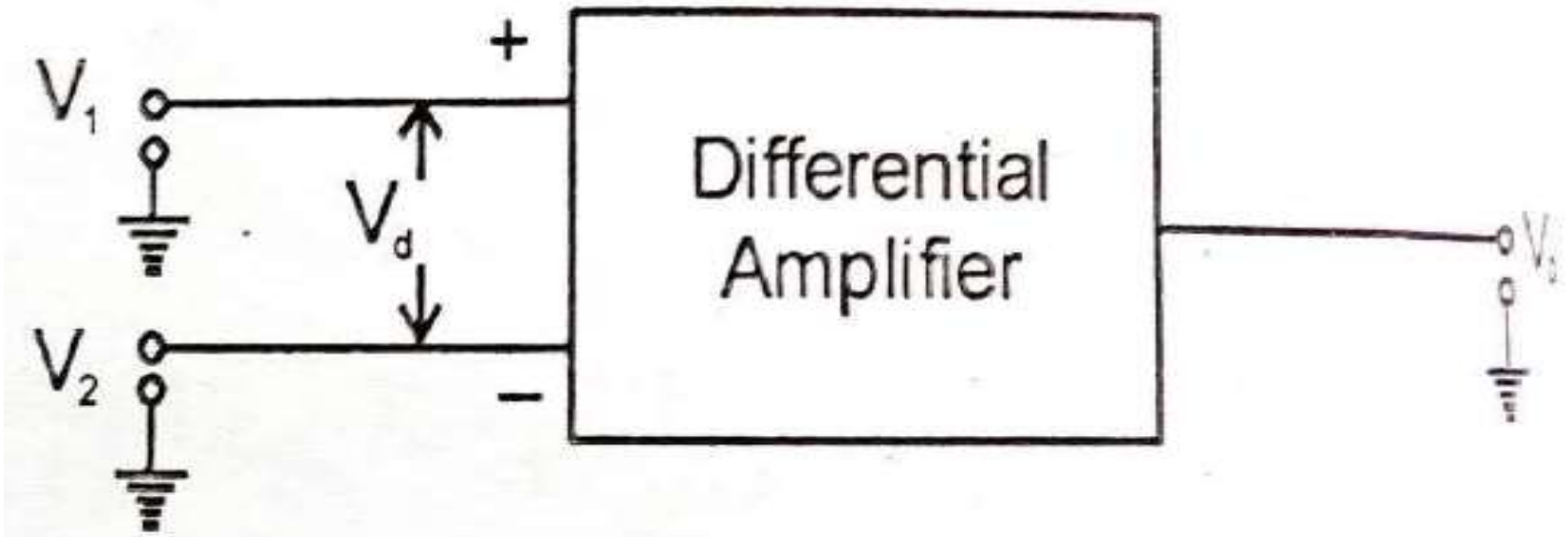
Transistor operation - Recall



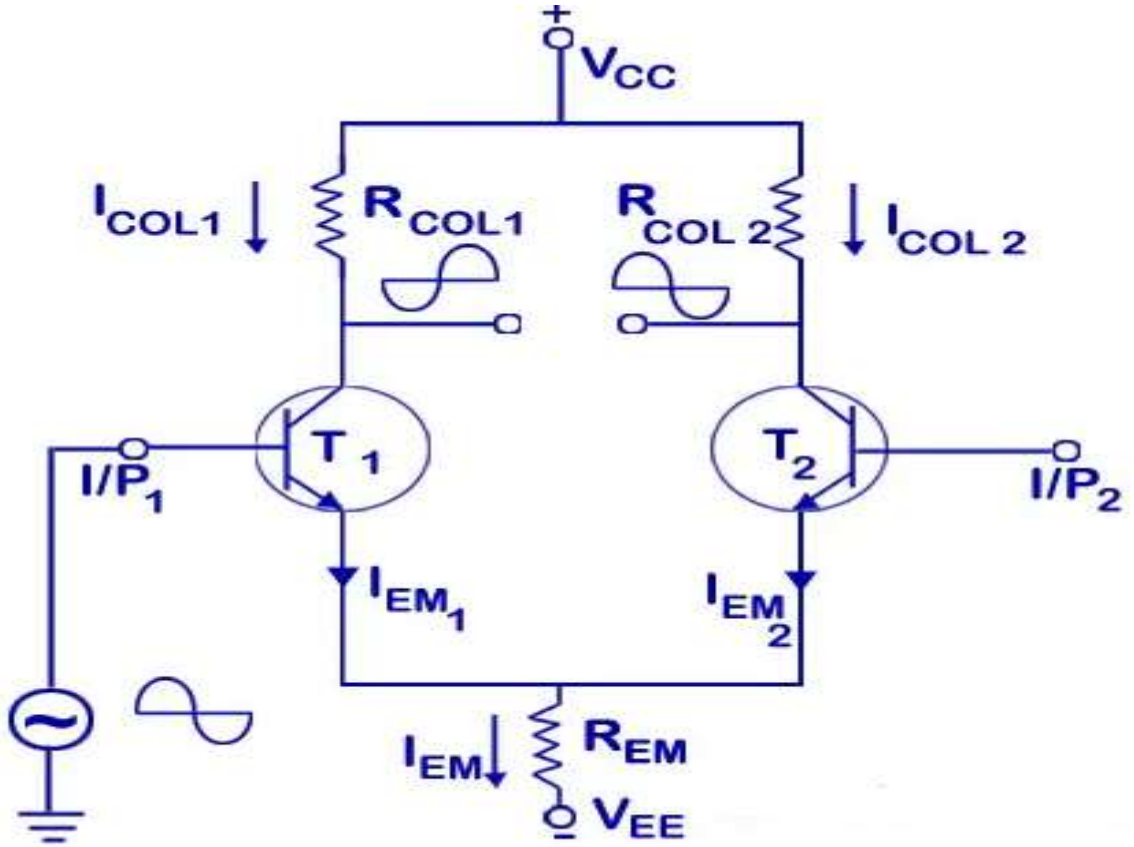
Introduction

- The function of differential amplifier is to *amplify the difference of two signals.*
- The need for differential amplifier in many physical measurements arises where response from d.c to many megahertz is required. It is also the *basic input stage of an integrated amplifier*

Block diagram of differential amplifier



Circuit Diagram of Differential Amplifier



Operation

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

$$V_o \alpha (V_1 - V_2)$$

Where,

V_1 & V_2 – Two input signals

V_o – Single ended output

Differential mode Gain

Differential Gain (A_d):

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

Where, A_d is the **constant of proportionality**.

A_d is the gain with which differential amplifier amplifies the difference of two input signals.

Hence it is known as '***differential gain of the differential amplifier***'.

$$A_d = \frac{V_o}{V_d} = -g_m R_C$$

V_1-V_2= Difference of two voltage

Common mode Gain

Common Mode Gain (A_d):

An average of the two input signals is called common mode signal denoted as V_c.

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

Hence, the differential amplifier also produces the output voltage proportional to common mode signals.

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

Where $\mathbf{A_c = - R_C / R_E}$, is the common mode gain.

Therefore, there exists some finite output for $V_1 = V_2$ due to common mode gain Ac.

Hence the total output of any differential amplifier can be given as,

$$\mathbf{V_o = A_d V_d + A_c V_c}$$

CMRR

Common Mode Rejection Ratio (CMRR):

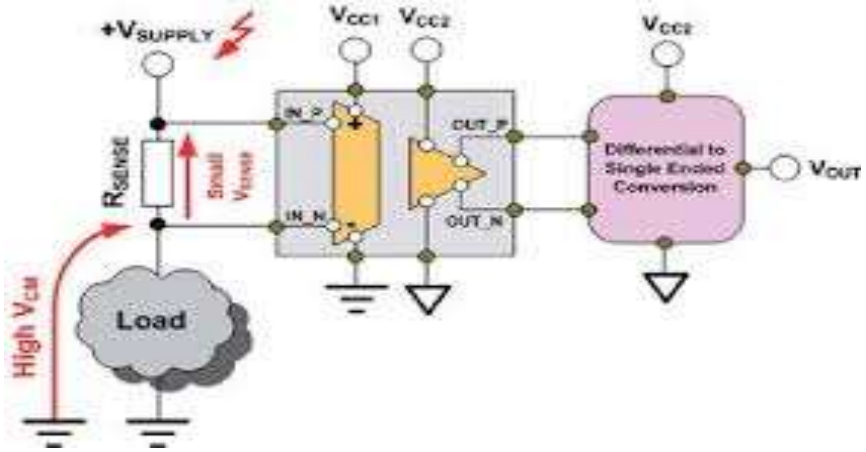
- The ability of a differential amplifier to reject a common mode signal is defined by a ratio called '***Common Mode Rejection Ratio***' denoted as CMRR.
- **CMRR** is defined as the ***ratio of the differential voltage gain*** A_d ***to common mode gain*** A_c and is expresses in dB.

$$\text{CMRR} = \text{Ad/Ac} = {}^{g}{}_{m}R_E$$

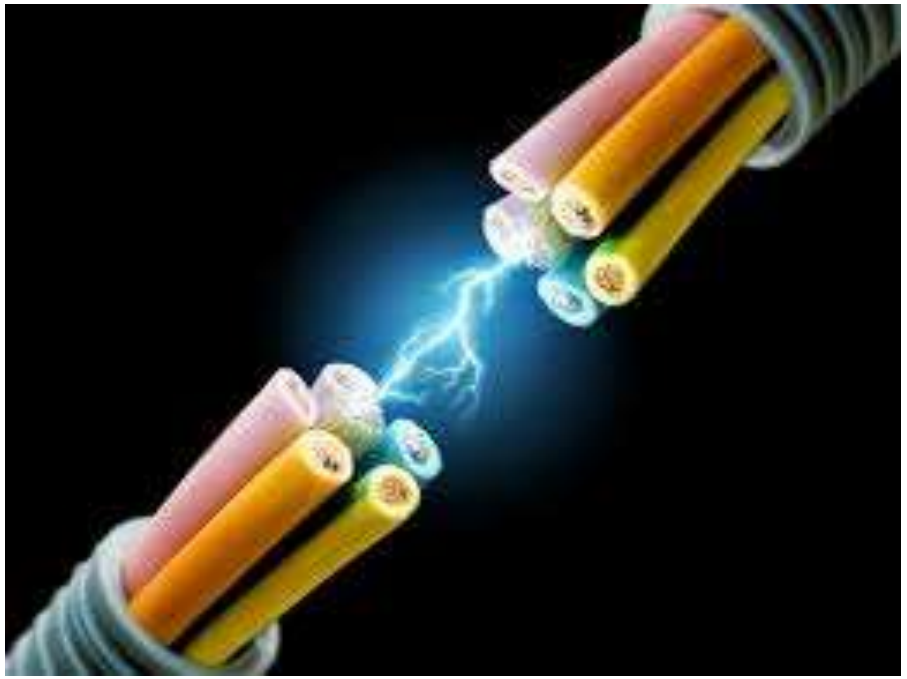
$$CMRR = 20\log\left|\frac{A_d}{A_c}\right| dB$$

Advantages & Applications

- Differential amplifiers are pervasive in analog electronics
  - Low frequency amplifiers
  - High frequency amplifiers
  - Operational amplifiers – the first stage is a differential amplifier
  - Analog modulators
  - Logic gates
- Advantages
  - Large input resistance
  - High gain
  - Differential input
  - Good bias stability
  - Excellent device parameter tracking in IC implementation
- Examples
  - Bipolar 741 op-amp (mature, well-practiced, cheap)
  - CMOS or BiCMOS op-amp designs (more recent, popular)



RECAP….



…THANK YOU