Topic 2.8 : Multistage amplifiers-Cascade and Cascode amplifier

Multistage Amplifiers

Amplifier :-

* Amplify a signal from a very weak source.
* This is achieved by cascading number of amplifier stages known as multistage Amplifier.

Need for cascading:-

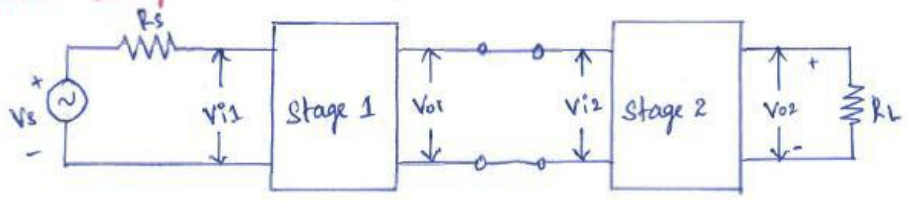
* Amplification of a single stage amplifier is not sufficient so, we go for cascading amplifier.

Multistage Amplifier - 2 Mark

* Voltage gain & power gain from single stage small signal amplifier is not sufficient for practical applications.
* Use more than one stage of amplifier to achieve necessary voltage & power gain. Such an amplifier is called multistage amplifier.
* In multistage output of one stage is feed as input to the next stage.

Cascaded Amplifier - 16 Mark

1. Two Stage Cascaded Amplifier



* Output of the 1st stage is connected to the input of the 2nd stage.
* V_{i1} is the input of the 1st stage & V_{o2} is the output of the 2nd stage
* $\therefore \frac{V_{o2}}{V_{i1}}$ is the overall voltage gain of the 2nd stage amplifier & it can be given as

$$A_V = \frac{V_{o2}}{V_{i1}} = \frac{V_{o2}}{V_{i2}} \cdot \frac{V_{i2}}{V_{i1}} \quad \because V_{o1} = V_{i2}$$

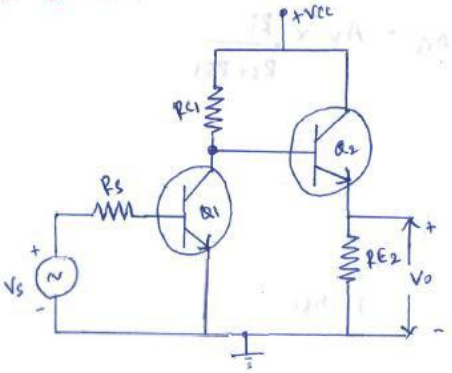
(or)

$$= \frac{V_{o2}}{V_{i2}} \cdot \frac{V_{o1}}{V_{i1}}$$

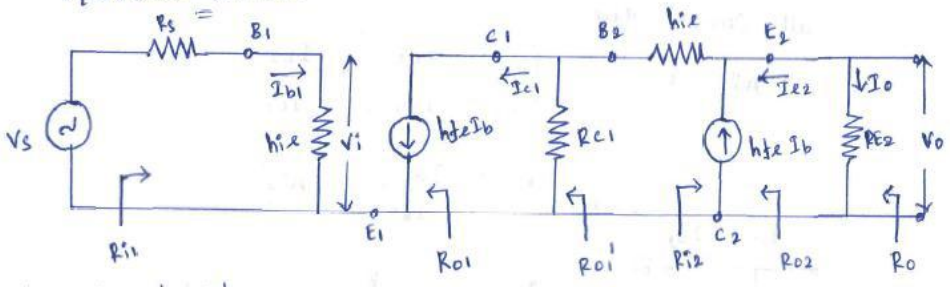
$$A_V = A_{V2} \cdot A_{V1}$$

* So that we can say the voltage gain of multistage amplifier is the product of voltage gain of the individual stages.

Common Emitter - Common collector Amplifier ※ 16 Marks.



Equivalent circuit:



Analysis of 2nd stage (cc amplifier)

1. Current gain
$A_{i2} = 1 + h_{fe}$

2. Input Impedance
$R_{i2} = h_{ie} + (1 + h_{fe}) R_{E2}$ (b)

3. Voltage gain
$A_{V2} = \frac{A_{i2} \times R_{L2}}{R_{i2}} = \frac{A_{i2} \times R_{E2}}{R_{i2}}$

Analysis of 1st stage (CE amplifier)

1. Current gain

$A_{i1} = -h_{fe}$

2. Input Impedance

$R_{i1} = h_{ie}$

3. Voltage gain

$A_{v1} = \frac{A_{i1} \times R_{L1}}{R_{i1}}$

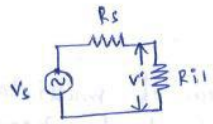
$R_{L1} = R_{C1} \| R_{i2}$

Overall Voltage gain

$A_v = A_{v1} \times A_{v2}$

Overall voltage gain (A_{vs}) :-

$A_{vs} = \frac{V_o}{V_s} = \frac{V_o}{V_i} \times \frac{V_i}{V_s}$



$V_i = V_s \times \frac{R_{i1}}{R_s + R_{i1}}$

$\therefore A_{vs} = \frac{V_o}{V_i} \times \frac{V_s}{1} \times \frac{R_{i1}}{R_s + R_{i1}}$ (cancel V_s)

$A_{vs} = A_v \times \frac{R_{i1}}{R_s + R_{i1}}$

Output Impedance

$R_{o1} = \infty \rightarrow$ for CE

$R_{o1}' = R_{o1} \| R_{C1}$

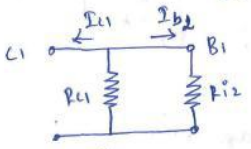
$R_{o2} = \frac{R_s + h_{ie}}{1 + h_{fe}}$ (for CC) $= \frac{R_{o1}' + h_{ie}}{1 + h_{fe}}$

$R_o = R_{o2} \| R_{E2}$

Overall Current gain

$A_i = \frac{I_o}{I_{b1}} = \frac{I_o}{I_{e2}} \times \frac{I_{e2}}{I_{b2}} \times \frac{I_{b2}}{I_{c1}} \times \frac{I_{c1}}{I_{b1}}$

$\frac{I_o}{I_{e2}} = -1$; $\frac{I_{e2}}{I_{b2}} = -A_{i2}$



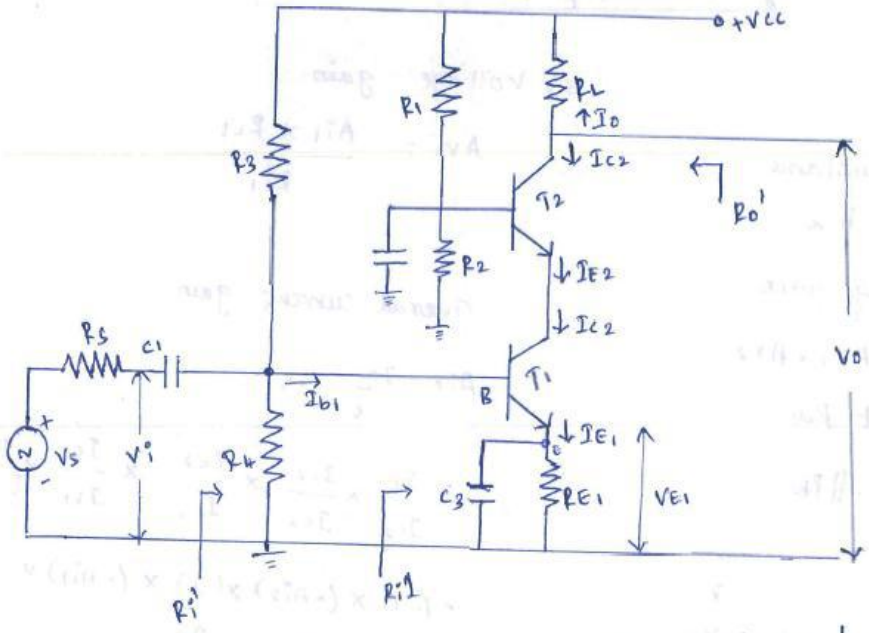
$\frac{I_{b2}}{I_{c1}} = \frac{-R_{c1}}{R_{i2} + R_{c1}}$; $\frac{I_{c1}}{I_{b1}} = A_{i1}$

$A_i = -1 \times (-A_{i2}) \times \left[\frac{-R_{c1}}{R_{i2} + R_{c1}}\right] \times A_{i1}$

$A_i = -A_{i1} A_{i2} \left(\frac{R_{c1}}{R_{i2} + R_{c1}}\right)$

Two stage RC coupled CE - CB cascode Amplifier — 16 Mark

* It consist of a CE amplifier stage in series with a CB amplifier.
* Transistor T_1 & its associated components operate as a CE amplifier stage, while the circuit of T_2 functions as a CB output stage.



* The cascode amplifier gives the high input impedance of CE amplifier, as well as the good voltage gain & high frequency performance of CB circuit.
* The I_{E1} for T_1 is fd by V_{E1} & R_{E1}.
* I_{C1} approximately equals I_{E1} & I_{E2} is same as I_{C1}.
* $\therefore I_{C2}$ approximately equals I_{E1}.
* This current remains constant regardless of the level of V_{B2} as long as V_{CE1} remains large enough for current operation of T_1.