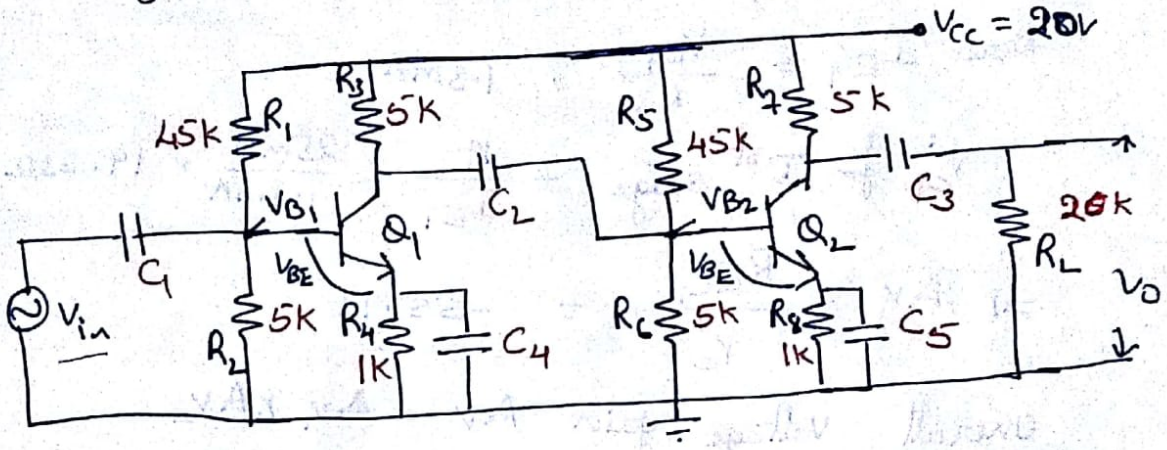
Unit-2 – Multistage Amplifiers

1. Compute the overall voltage gain for the 2-stage R-C Coupled amplifier shown in fig. Express the gain in dBs. by Cauridering $V_{BE} = 0.7V$ & $\beta_1 = \beta_2 = 100$.



Sol:-

(i) V_{B_2} Voltage across B of Q_2

$$V_{B_2} = \frac{V_{CC} \cdot R_6}{R_5 + R_6} = 2V$$

$$\Rightarrow V_{E_2} = V_{B_2} - V_{BE} = 2 - 0.7 = 1.3V$$

Now I_{E_2} across $R_8 \Rightarrow I_{E_2} = \frac{V_{E_2}}{R_8} = 1.3mA$

$\Rightarrow$ the $r'_{e_2} = \frac{V_T}{I_{E_2}} = \frac{25mV}{1.3mA} = 19.23\Omega$ [r'_e internal forward resistance]

$\Rightarrow$ $Z_{in(Base)}$ for 2nd stage $= \beta r'_{e_2} = 1.923K\Omega$

$\Rightarrow$ I/P impedance for 2nd stage

$$Z_{in_2} = R_5 \| R_6 \| Z_{in(Base)} = 1.347K$$

Effective collector load for 2nd stage

$$R_{ac_2} = R_7 \| R_L = 4K\Omega$$

Voltage gain of 2nd stage $A_{V_2} = -\frac{R_{ac_2}}{r'_{e_2}} = -208$

output collector load for I st stage

$$R_{ac_1} = R_3 // Z_{in_2} = 1.06 K\Omega$$

$$V_{B_1} = \frac{V_{cc} R_2}{R_1 + R_2} = 2V$$

$$V_{E_1} = V_{B_1} - V_{BE} = 1.3V$$

Now $I_{E_1} = \frac{V_{E_1}}{R_4} = 1.3mA$

r'_{e_1} for I st stage $= \frac{V_T}{I_{E_1}} = \frac{25mV}{1.3mA} = 19.23\Omega$

$$\Rightarrow A_{V_1} = \frac{R_{ac_1}}{r'_{e_1}} = -55.12$$

Overall voltage gain $A_V = A_{V_1} \times A_{V_2}$

$= 11,465$

gain in dBs $= 81.2 dB.$

2. The RC coupled amplifier has Mid freq gain $= 100$. The values of lower & upper cutoff freqs are $f_1 = 80 Hz$ & $f_2 = 80 KHz$. Find the freqs at which the gain is reduced to 80.

given $(A_V)_m = 100$; $f_1 = 80Hz$ $f_2 = 80KHz$

where $(A_V)_l = \frac{(A_V)_m}{\sqrt{1 + (f_1/f)^2}} = \frac{(A_V)_m^2}{(A_V)_l^2} = 1 + (f_1/f)^2$

$$\frac{(A_V)_m^2}{(A_V)_l^2} - 1 = (f_1/f)^2$$

$$\Rightarrow f = \frac{f_1 (A_V)_l}{\sqrt{(A_{V_m} + A_{V_l})(A_{V_m} - A_{V_l})}} =$$

$A_{V_l} = A_{V_h} = 80$

Wkg $(A_V)_h = \frac{(A_V)_m}{\sqrt{1 + (f'/f_2)^2}} \Rightarrow f' = f_2 \sqrt{\frac{(A_{V_m} + A_{V_h})(A_{V_m} - A_{V_h})}{A_{V_h}}}$

(3) 3 - identical stages in a multistage amplifier have an overall upper 3dB freq of 40KHz & lower 3dB freq of 15KHz. what is the operating Bandwidth of each amplifier stage ?

no of stages $n = 3$

overall lower 3dB freq $f_1^n = 15\text{KHz}$

overall upper 3dB freq $f_2^n = 40\text{KHz}$

$$\Rightarrow f_1^n = \frac{f_1}{\sqrt{2^{1/n} - 1}} \Rightarrow f_1 = f_1^n \sqrt{2^{1/n} - 1}$$

$$\Rightarrow f_2^n = f_2 \sqrt{2^{1/n} - 1} \Rightarrow f_2 = f_2^n / \sqrt{2^{1/n} - 1}$$