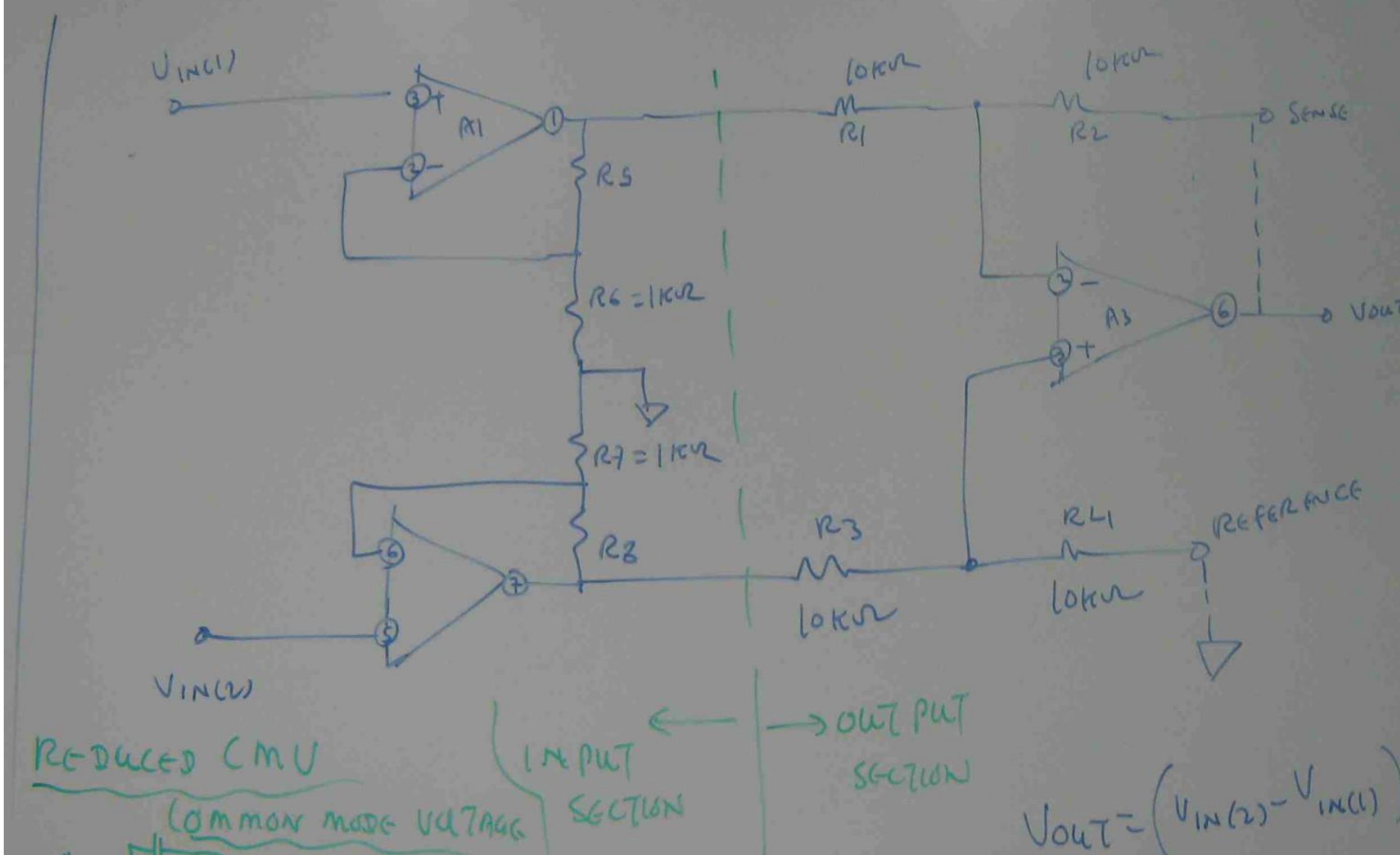
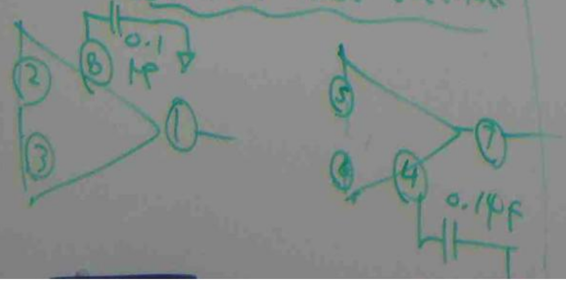
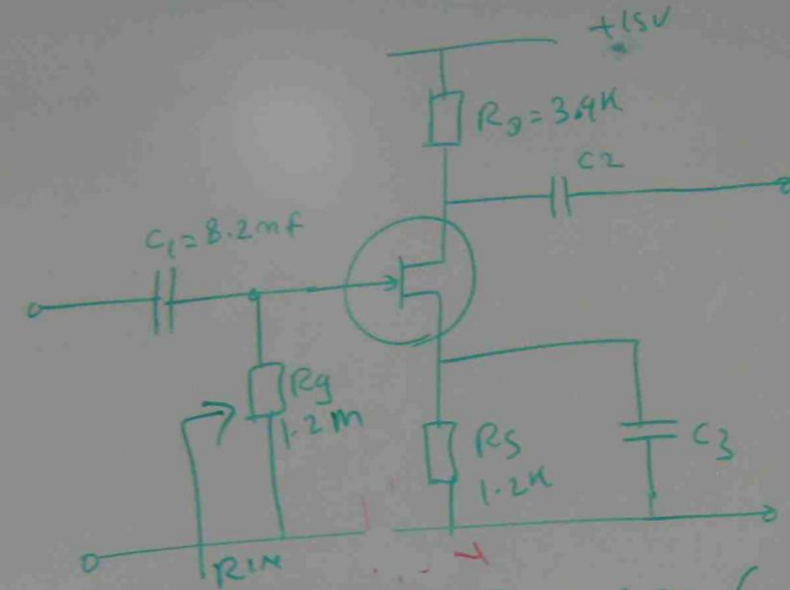
A BUFFERED SUBTRACTOR WITH BUFFER AMPLIFIERS OPERATING WITH GAIN





$$V_{OUT} = \left(V_{IN(2)} - V_{IN(1)}\right)\left(1 + \frac{2R_2}{R_6}\right)\left(\frac{R_2}{R_1}\right)$$

FOR $R_1 = R_3$, $R_2 = R_4$, $R_5 = R_6$



CALCULATE THE CUT OFF FREQUENCY f_1 OF GIVEN CIRCUIT

$$f_1 = \frac{1}{2\pi R_{IN} C_c}$$

$C_c = C_1 = 8.2\ nF$

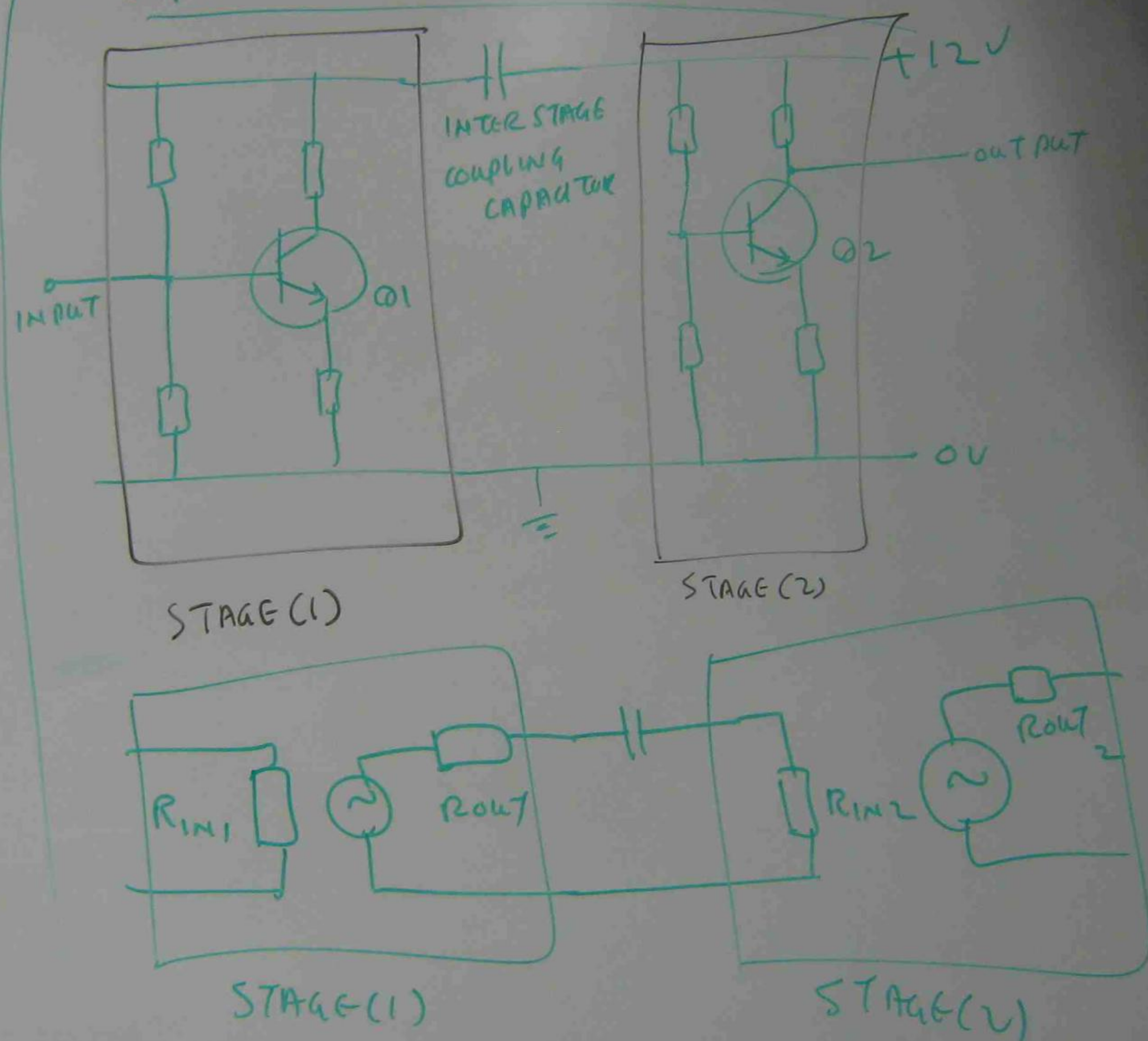
$R_{IN} = R_s = 1.2\ M\Omega$

$$f_1 = \frac{1}{2 \times 3.1416 \times 1.2 \times 10^6 \times 8.2 \times 10^{-9}}$$

$$= \frac{1}{6.28 \times 1.2 \times 8.2 \times 10^{-3}}$$

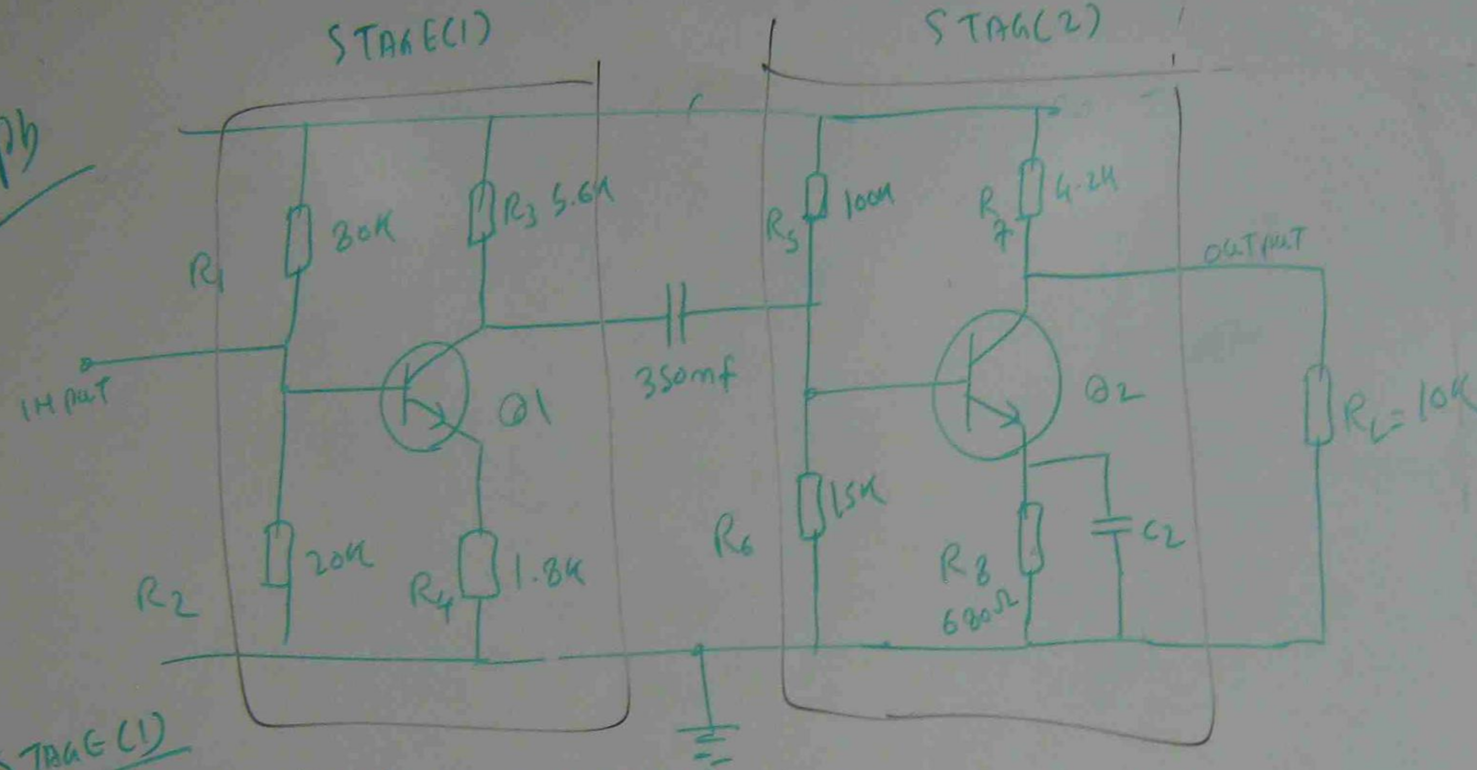
$$= \frac{1000}{6.28 \times 1.2 \times 8.2} = 16.2\ Hz$$

CAPACITIVELY COUPLED MULTI STAGE AMPLIFIERS



2

Pb



STAGE(1)

$r_e = 26\Omega$

$\beta_1 = 300$

STAG(2)

$r_e = 18.3\Omega$, $\beta_2 = 400$

FIND $R_{IN}1$, $R_{OUT}(1)$ $R_{IN(2)}$, $R_{OUT(2)}$, A_{V_1}, A_{V_2}, $A_{V_{TOTAL}}$

STAGE(1)

$R_1 || R_2$

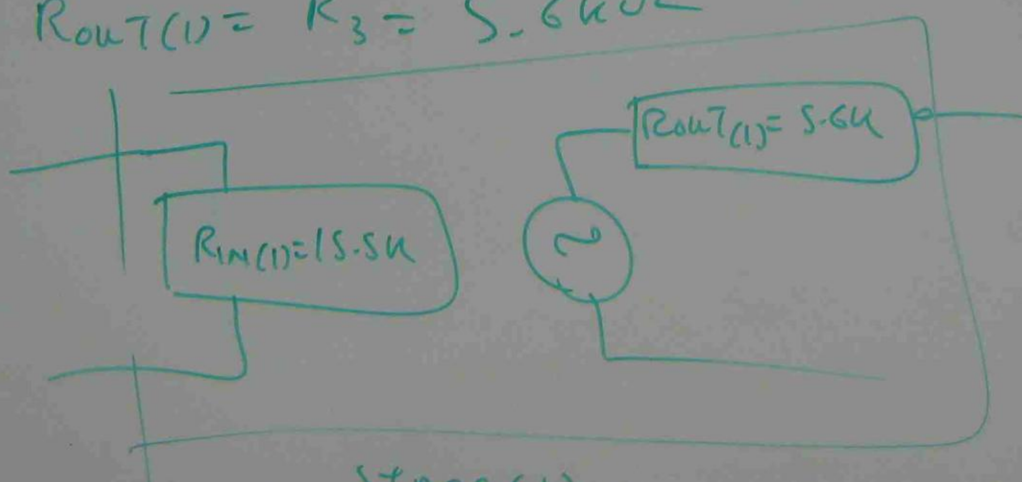
$$R_{IN\,(1)} = R_1 || R_2 || \beta(R_4 + r_{e_1})$$

$$= 80k || 20k || 300\left(1.8k + \frac{26}{1000}\right)$$

$$= \frac{80 \times 20 \times 300\left(1.8 + \frac{26}{1000}\right)}{80 \times 20 + 20 \times 300\left(1.8 + \frac{26}{1000}\right) + 80\left(1.8 + \frac{26}{1000}\right)}$$

$$= 15.5\,k\Omega$$

$$R_{OUT(1)} = R_3 = 5.6\,k\Omega$$



STAGE(1)

$R_1 || R_2 || R_3 \longrightarrow R_T = \dfrac{R_1 R_2 R_3}{R_1R_2 + R_2R_3 + R_3R_1}$

$\frac{26}{1000})$

STAGE(2)

$$R_{IN2} = R_5 || R_6 || \beta_2 \times re_2$$

$$= 100k || 15k || \frac{400 \times 18.3}{1000}$$

$$= \frac{100 \times 15 \times \frac{400 \times 18.3}{1000}}{100 \times 15 + 15 \times \frac{400 \times 18.3}{1000} + \frac{100 \times 400 \times 18.3}{1000}}$$

$$= 4.69 k\Omega$$

$R_{OUT(2)} = 4.2k$

$$Av_1 = \frac{R_3 || R_{IN2}}{R_4 + r_{e1}} = \frac{\frac{5.6 \times 4.69}{5.6 + 4.69}}{1.8 + \frac{26}{1000}} = 1.4$$

$$AV_2 = \frac{R_7 \parallel RL}{r_{e2}}$$

$$= \frac{4.2K \parallel 10K}{\frac{18.3}{1009}}$$

$$= \frac{\frac{4.2 \times 10}{4.2+10}}{\frac{18.3}{1009}}$$

$$= 162$$

$$AV_T = AV_1 \times AV_2$$

$$= 1.4 \times 162$$

$$= 227$$

CUT OFF FREQUENCY

$$f_1 = \frac{1}{2\pi R_T C_c}$$

$$R_T = R_{OUT\,1} + R_{IN2}$$

$$= 5.6 + 4.69 = 10.29$$

$AV_T = AV_1 \times AV_2$

$= 1.4 \times 162$

$= 227$

CUT OFF FREQUENCY

$$f_1 = \frac{1}{2\pi R_T C_C}$$

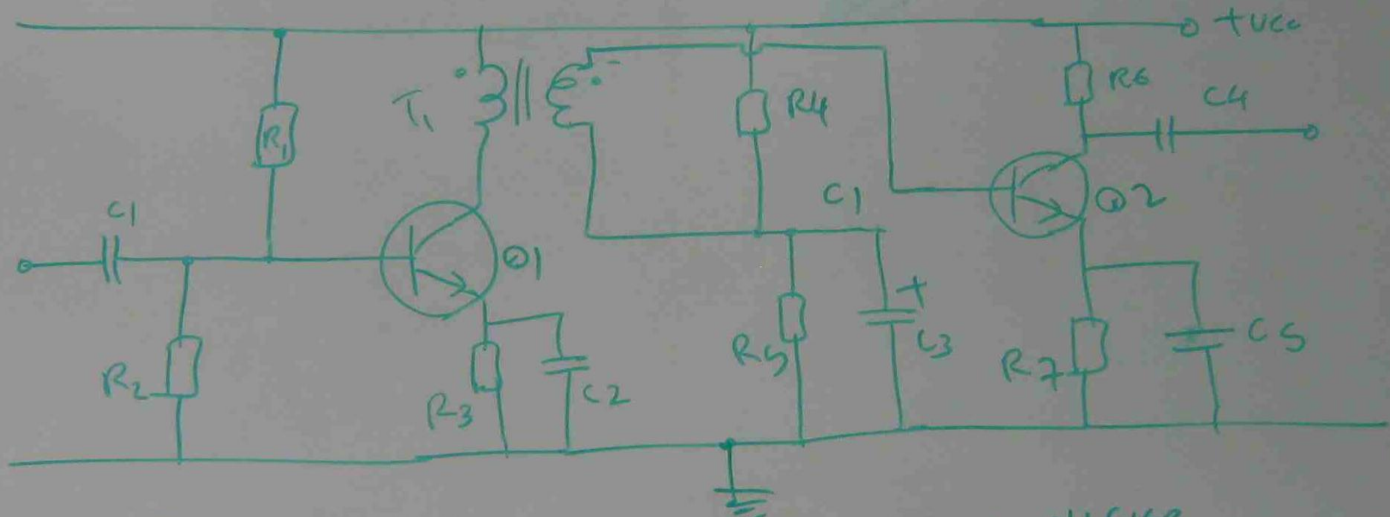
$R_T = R_{OUT\,1} + R_{IN2}$

$= 5.6 + 4.69 = 10.29$

$$f_1 = \frac{1}{2 \times 3.1416 \times 10.29 \times 10^3 \times 350 \times 10^{-9}}$$

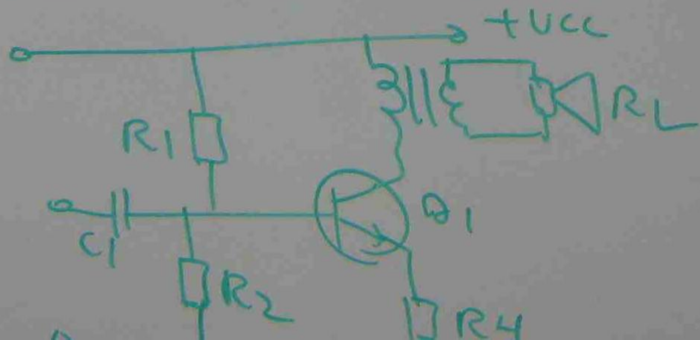
$= 44.19\ Hz$ ※

TRANSFORMER COUPLED AMPLIFIERS



MORE EFFICIENT THAN RC COUPLED AMPLIFIER
BUT MORE DISTORTION AND POOR FREQUENCY RESPONSE

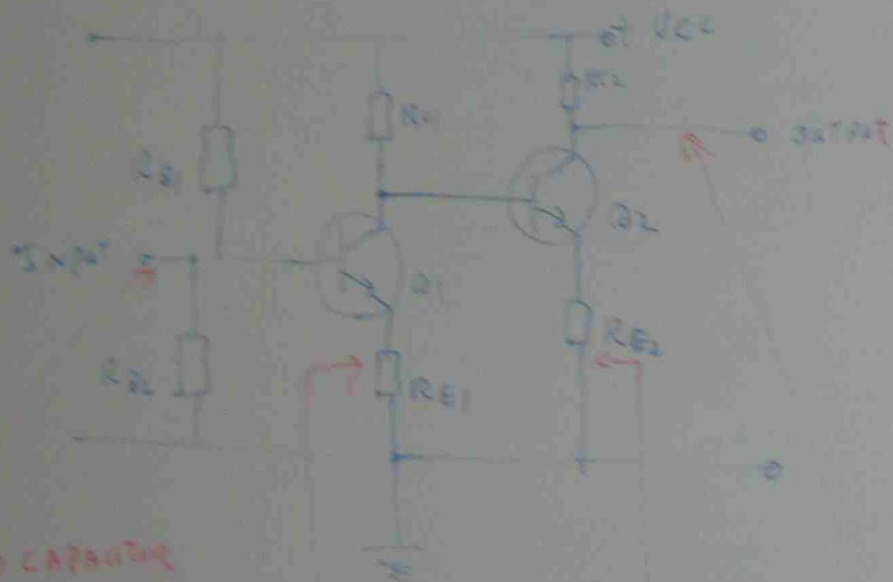
POWER AMPLIFIER (OUTPUT STAGE TRANSFORMER COUPLED)



AUDIO AMPLIFIER

DIRECT COUPLING AND INTRODUCTION TO THE DIFFERENTIAL AMPLIFIER

DIRECT COUPLED - NO COUPLING CAPACITOR



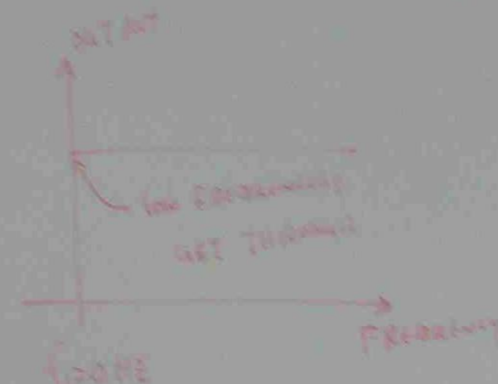
NO CAPACITOR

NO CAPACITOR

NO CAPACITOR

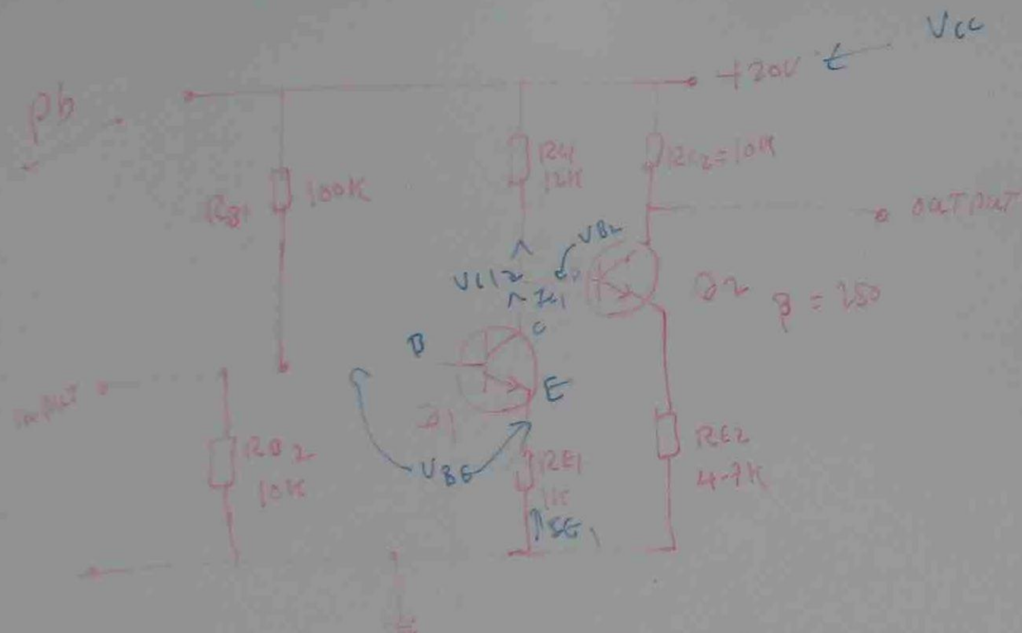
REASON

NO LIMITATIONS ON THE LOWER FREQUENCY RESPONSE



DISADVANTAGES

- NO DC STABILITY
- DRIFT DUE TO TEMPERATURE VARIATIONS



CALCULATE V_{B1}, I_{E1}, I_{C1}

V_{B2}, V_{E2}, I_{C2}

I_{C2}

DC GAIN, R_{IN2}

A_{V1}, $A_{V\,TOTAL}$

$$V_{B_1} = V_{CC} \times \frac{R_{B2}}{R_{B_1} + R_{B2}}$$

$$= 20 \times \frac{10K}{100K + 10K}$$

$$= 1.82V$$

$$V_{E1} = V_{B_1} - V_{BE} \quad \left\{ \begin{array}{l} V_{BE} = 0.6\ V \ \text{SILICON} \\ V_{BE} = 0.2V \ \text{Ge} \end{array} \right\}$$

$$= 1.82 - 0.6 = 1.22V$$

$$I_{C_1} \simeq I_{E_1} = \frac{V_{E1}}{R_{E_1}} = \frac{1.22V}{1K} = 1.22\ \text{mA}$$

$$V_{C_1} = V_{CC} - I_{C_1} R_{C_1} = 20 - 1.22\times10^{-3} \times 12\times10^{3}$$

$$= 5.36V$$

$$V_{B_2} = V_{C_1} = 5.36V$$

DIRECT COUPLED

$V_{E2} = V_{B2} - V_{BE} = 5.36 - 0.6 = 4.76\,V$

$$I_{C2} = I_{E2} = \frac{V_{E2}}{R_{E2}} = \frac{4.76\,V}{4.7\times10^{3}} = 1.01\,mA$$

$$V_{C2} = V_{cc} - (I_{C2}\times R_{C2})$$

$$= 20 - 1.0\times10^{-3}\times 10\times10^{3}$$

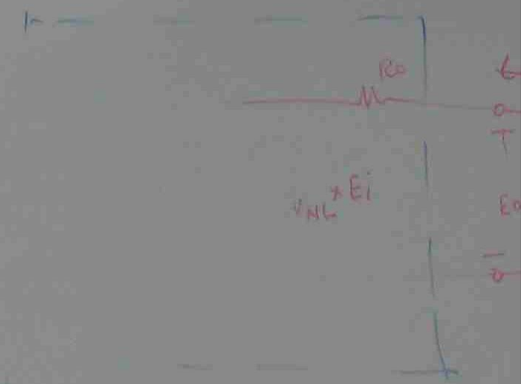
$$= 9.9\,V$$

$$A_{V2} = \frac{R_{C2}}{R_{E2}} = \frac{10k}{4.7k} = 2.13$$

$$R_{IN2} = \beta\times R_{E2} = 250\times4.7k = 1.18\,M\Omega$$

$$A_{V1} = \frac{R_{C1}}{R_{E1}} = \frac{12k}{1k} = 12$$

$$A_{V_T} = A_{V1}\times A_{V2} = 12\times2.13 = 25.6$$



$$I_o = -\frac{A_{vNL}\,E_i}{R_L + R_o}$$

$$E_i = I_i R_i$$

$$I_o = -\frac{A_{vNL}\,(I_i R_i)}{R_L + R_o}$$

$$A_I = \frac{I_o}{I_i} = -A_{vNL}\times\frac{R_I}{R_L + R_o}$$