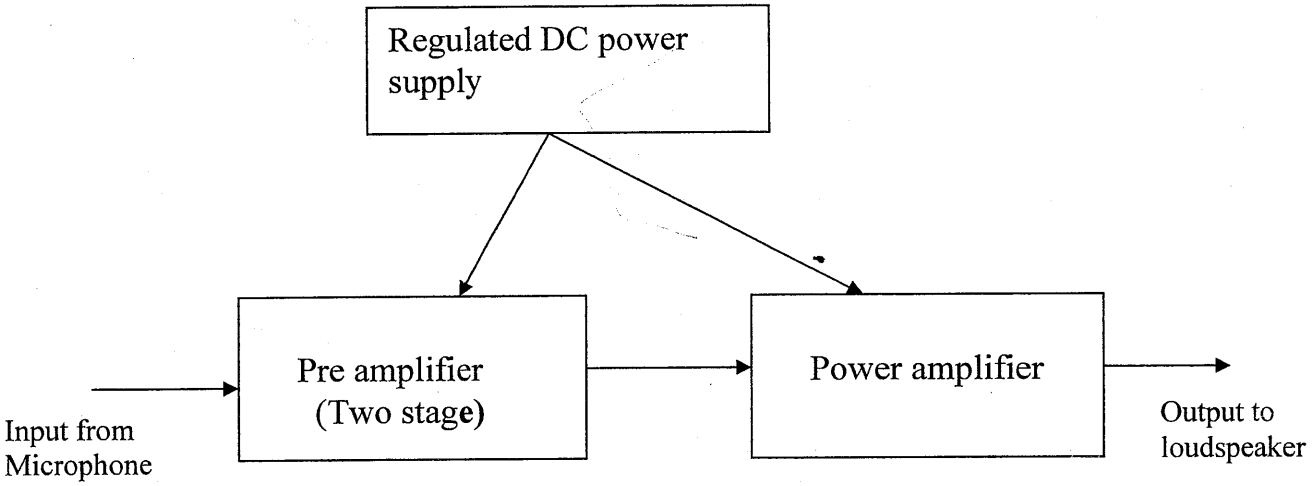
MAJOR ASSESMENT-1

It is required to design, simulate and implement an audio amplifier, the specifications of the design are explained below. A suggested block diagram of the amplifier is given. You are required to show all design work, and simulation results in your assignment, **including calculations for all components values.**
Note: clearly show any assumption made

Block diagram of the circuit:

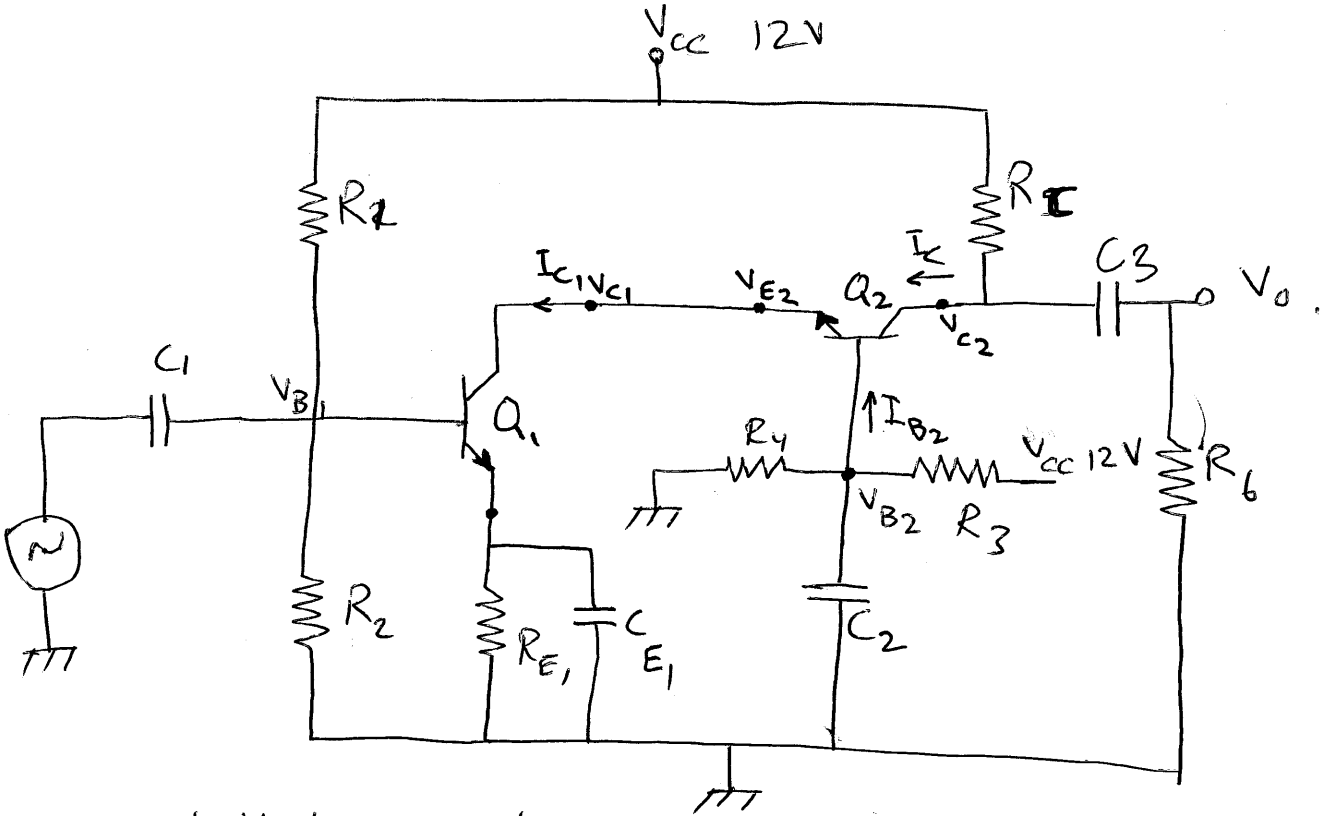


Design specifications:

1) DC regulated power supply with AC line voltage equal to 230V, the output DC voltage is equal to 12V and output current Io = 400mA. The rectifier type is a full wave bridge rectifier. The filter is a capacitor filter with ripple factor less than 3%. Use a 7812 regulator IC.
2) Two stage Pre amplifier is a Cascode amplifier with input voltage = 220mV(rms), the lower cut-off frequency = 70 Hz and maximum output = 3V(rms)
3) Power Amplifier is a class AB push pull amplifier
4) You may assume proper quiescent operating conditions to do your design

Note: Circuit implementation and final report of the assignment including all design details, simulation results should be submitted before the end of the 7th week of the semester any late submission of the assignment will not be accepted at all.
Reports should be submitted individually by each student.

Please clearly indicate all references you used.



- Input Voltage = 220 mV (RMS)
- output voltage = 3 V (RMS)

f_L = 70 Hz.

From Q point stats in the data sheet of the transistor 2N2222.

$I_{C_{sat}} = 10\,mA \Rightarrow \boxed{I_C = 5\,mA}$ | $V_{CE_{cutoff}} = 10\,V \Rightarrow \boxed{V_{CE} = 5\,V}$

$$V_{B_1} = V_{CC} \frac{R_2}{R_1 + R_2}$$

$$I_{C_1} \simeq I_{E_1}$$

$\because I_{E_2} = I_{C_1} = 5\,mA \Rightarrow I_{E_1} = I_{C_2} = 5\,mA.$

let $V_{E_1} = 10\%\, V_{CC} = 12 \times 0.1 = 1.2\,V.$

$$R_{E_1} = \frac{V_{E_1}}{I_{E_1}} = \frac{1.2}{5\,mA} = 240\,\Omega$$

$R_E = 240\,\Omega$

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

$V_{B_1} = 1.2 + 0.7 = 1.9\,V.$

$V_{B_1} = 1.9\,V$

$$V_{B_1} = V_{CC} \frac{R_2}{R_1 + R_2}$$ let $I_{R_1} = 10\, I_{B_1}$

$$I_{B_1} = \frac{I_{C_1}}{\beta} = \frac{5}{100} = 0.05\,mA.$$ we take $\beta = 100$

$I_{B_1} = 50\,\mu A$

$\Rightarrow I_{R_1} = 0.5\,mA$

$V_{R_1} = V_{CC} - V_{B_1} = 12 - 1.9 = 10.1\,V.$

$$R_1 = \frac{V_{R_1}}{I_{R_1}} = \frac{10.1}{0.5\,mA} = 20.2\,K\Omega$$

$R_1 = 20.2\,K\Omega$

$$V_{B_1} = V_{CC} \frac{R_2}{R_1 + R_2} \Rightarrow 1.9 = 12 \frac{R_2}{20.2 + R_2}$$

$R_2 = 3.8\,K\Omega$

$\Rightarrow 12\,R_2 = 38.38 + 1.9\,R_2$

$10.8\,R_2 = 38.38\,K \Rightarrow R_2 = 3.8\,K\,\Omega.$

$$V_{B_2} = 12 \frac{R_4}{R_3 + R_4}$$

Let $I_{R_3} = 10 I_{B_2}$ $\quad I_{B_2} = \frac{I_{C_2}}{\beta} = \frac{5mA}{100} = 50\mu A$

$\Rightarrow I_{R_3} = 0.5\,mA$

$V_{R_3} = V_{CC} - V_B$

$R_{R_3} = I_{R_3} R_3$

$V_{E_2} = 10\% V_{CC} = 12 \times 0.1 = 1.2$

$V_{CC} - I_C R_C - V_{CE} = 0$

$12 - 5mA R_C - 5 = 0$

$\boxed{R_C = 1.4\,K\Omega}$

$V_{E_2} = V_{B_2} - V_{BE} \Rightarrow$

$V_{B_2} = V_{E_2} + V_{BE} = 1.2 + 0.7 = 1.9\,V.$

Let $I_{R_3} = 10 I_{B_2} \Rightarrow I_{R_3} = 10 \times 50\,\mu A$

$\Rightarrow I_{R_3} = 0.5\,mA.$

$V_{R_3} = V_{CC} - V_{B_2} = 12 - 1.9 = 10.1\,V$

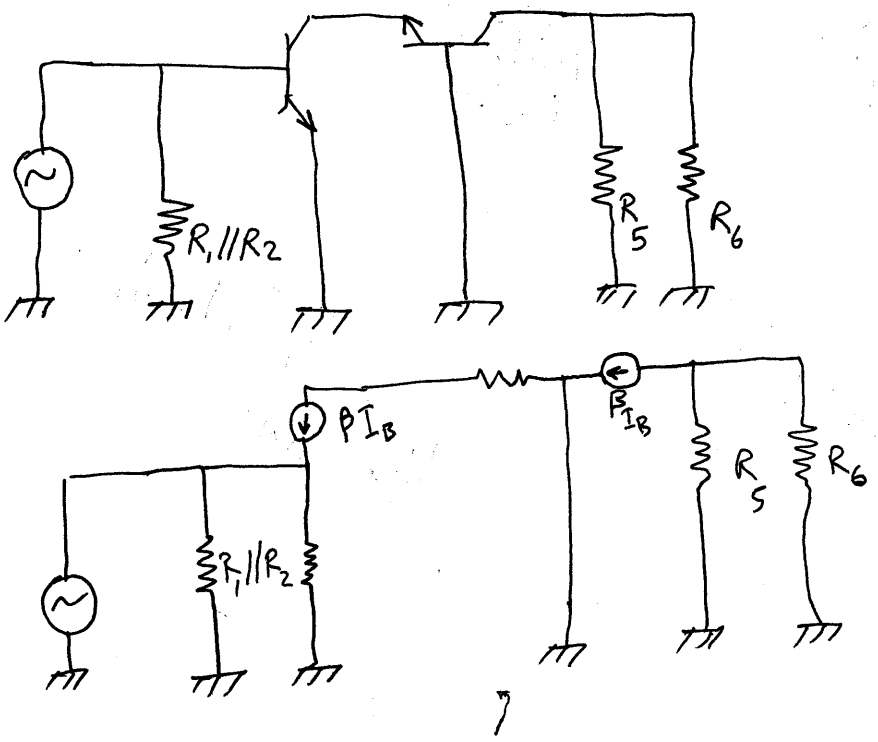
$R_3 = \frac{10.1}{0.5\,mA} = 20.2\,K\Omega$ $\quad \boxed{R_3 = 20.2\,K\Omega}$

$V_{B_2} = V_{CC} \frac{R_4}{R_3 + R_4} \Rightarrow 1.9 = 12 \frac{R_4}{20.2K + R_4}$

$\Rightarrow \boxed{R_4 = 3.8\,K\Omega.}$

$V_{in} = 220\ mV$ $V_{out} = 3V$

$f_L = 70\ Hz.$



$\Rightarrow$

$$C_1 = \frac{1}{2\pi f_c R_{in}}$$

$R_{in} = R_1 // R_2 // R_{in\ Base}$ $\Rightarrow R_{in\ base} = \beta r\acute{e} = \beta \times \frac{25mV}{5mA}$

$= 100 \times 5 = 500$

$= \frac{20.2 \times 3.8}{20.2 + 3.8} // R_{in\ base}$

$= \frac{76.67}{24} // 500 = \frac{3.19 \times 500}{3.19 + 500} = 3.16\ K\Omega.$

$C_1 = \frac{1}{2\pi f_c R_{in}} = \frac{1}{2\pi \times 70 \times 3.16 \times 10^3} = \frac{1}{1389.136 \times 10^3}$

$\simeq 0.71\ \mu F.$

Finding. C_{E_1}

$$X_c = \frac{R_E}{10} = \frac{240}{10} = 24$$

$$C_E = \frac{1}{2\pi X_c f_L} = \frac{1}{2\pi \times 24 \times 70} = \frac{1}{10550.4} = 94.8\,MF.$$

$$C_2 = \frac{1}{2\pi \times f_{c_2} R_{in}} =$$

$R_{in} = R_4 // R_3 // R_{in\,base}$ $\quad R_{in\,Base} = \beta \frac{26\,mV}{I_E} = 100 \times 5 = 500\Omega$

$R_{in} = 3.16K$

$\Rightarrow C_2 = 0.71\,\mu F$

$$C_3 = \frac{1}{2\pi f_{c_3} R_c} = \frac{1}{2\pi f_{c_3} \times 1.4K} = \frac{1}{615440} = 1.6\,MF$$

$$C_c = \frac{1}{2\pi f_{c_1} R_c} = \frac{1}{2\pi \times 70 \times 1.4} = 1.6\,MF.$$

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