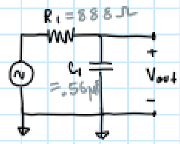
Low Pass filter



• Cutoff @ 320 Hz ± 10%

$$F_c = \frac{1}{2\pi R_1 C_1} \qquad C_1 = .56\mu F$$

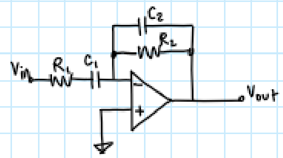
$$(2\pi .56\mu F)\ 320 = \frac{1}{2\pi R_1 (.56\mu F)}\ (2\pi .56\mu F)$$

$$.001126 = \frac{1}{R_1}$$

$$R_1 = 888\,\Omega$$

Procedure: build circuit in figure X. Use Y components. Check by doing Z

Mid Pass filter



• bandwidth 320 Hz → 3200 Hz ± 10%

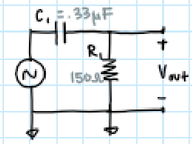
$$F_{c1} = \frac{1}{2\pi R_1 C_1} \qquad F_{c2} = \frac{1}{2\pi R_2 C_2}$$

$$C_1 = 10\mu F \qquad C_2 = 1\ \mu F$$

$$320 = \frac{1}{2\pi R_1\, 10\mu F} \qquad 3200 = \frac{1}{2\pi R_2\, 1\ \mu F}$$

$$R_1 = 49.7\,\Omega \qquad R_2 = 49.7\,\Omega$$

High pass filter



• cutoff @ 3200 Hz ± 10%

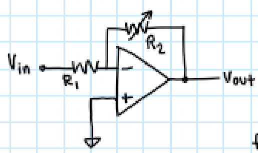
$$F_c = \frac{1}{2\pi R_1 C_1}$$

$$(2\pi .33\mu F)\ 3200 = \frac{1}{2\pi R_1\, .33\mu F}\ (2\pi .33\mu F)$$

$$.00664 = \frac{1}{R_1}$$

$$R_1 = 150\,\Omega$$

Volume control – LM356

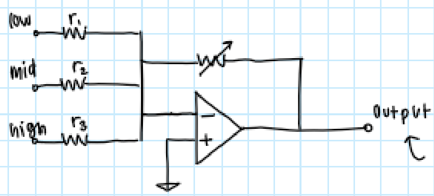


• attach V_{in} to output
• V_{out} to signal recombination

R_2 → 10K pot
find R_1 off of R_2
- starting @ 10k for max gain of 1
- to get R_1, adjusted Ω until voltage max output is equal across all 3

Low Pass: R_1: 20kΩ
Mid Pass: R_1: 11kΩ
High Pass: R_1: 9.1kΩ

Summation op amp – adjustable gain



$$V_{out} = -R_{out} \cdot \left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$$

Abstract

- audio technology
- created audio equilizer
- created audio amplifier – calculated
- simulated in SPICE
- circuit created
- measured outputs
- played music
- used passive & active filters
  - High & low
  - mid

Objective

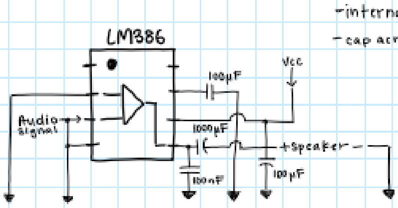
- create analog audio equalizer & amplifier
- freq range: ≤320 Hz, 320 Hz – 3200 Hz, ≥3200 Hz
- overall volume control
- amplifier to make it able to drive speakers
- tested through oscilloscope & playing audio

Conclusion

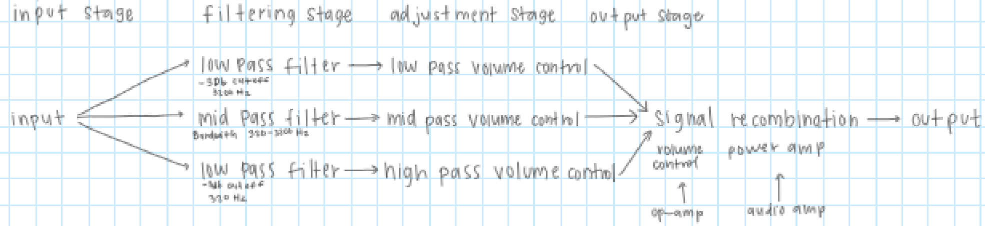
- Experiment completed objectives
- Graphs & demo were successful
- Audio produced was clean

Amplification

- internal Gain: 20
- cap across 1 & 8 will increase gain



Equalizer



Power amp
- we use class AB amp → low power multistage transistor amp
- more current than op-amps

Quick Review – Passive filters
- Lab 8

Active filtering
- Involves op-amp component
  → controllable gain
  → better output isolation
  → higher-order cutoff rate

Buffering
- Most important part of this project
  - terminal impedances : another form of loading
- view this project as input loading
  - back end of circuit begins to effect the front end
  - If you try to change the cutoff of 1 filter, it likely will change the cutoffs of the other 2
    - get around this by creating voltage followers through buffer implementation

Buffers isolate an input signal from output signal
- takes input signal ⇨ electrically recreates it on the output
  → 2 seperate circuits

* If you cant get cutoffs right, try putting a buffer before input of filter

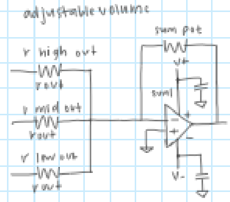
Volume control
- reliably reduce amplitude of outgoing waveform
- use op-amp & resistor
  - op-amps carry an isolation property
    * less intense than buffer

Signal Recombination
- summation amplifiers → normal inverting amps w/ multiple inputs on negative terminal
  - basic & add signals to 1 combined

High pass & low pass
- similar - just cap/resistor placement

Mid pass → RLC filter → better sound / harder to calculate
→ High pass + buffer + low pass easier to calculate / sounds "Tinny"

adjustable volume

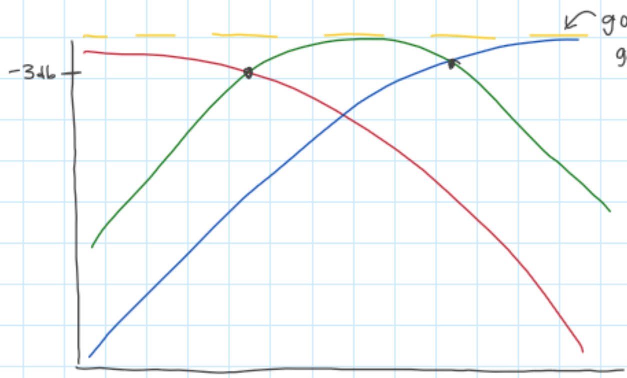


- clipping audio sounds weird

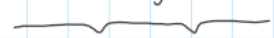
• Equations in lab manual

3/4 circuits → all work in par

Adjust volume → op amp w/ adjustable gain - use pot to adjust gain
→ modified amplifier like in op-amp lab



goal is to keep gain as level as possible

gain wont look like a straight line
- will go 
- minimize ripple

High pass - cutoff @ 3200 Hz +/- 10%
Mid pass - bandwidth from 320 Hz - 3200 Hz +/- 10%
Low pass - cutoff @ 320 Hz +/- 10%

factor of 10 - easily changed by changing cap by factor of 10