AUDIO ELECTRONICS TEST 1

dBs

- dB= 20log($V_{measured}/V_{ref}$)
- dBV= 20log($V_{measured}/1V_{rms}$)
- dBu= 20log($V_{measured}/.775V_{rms}$)

Nominal Levels

- Pro audio= +4dBu = 1.23 $V_{rms}$
- Consumer= -10dBV= .318$V_{rms}$ (line level)

Dynamic Range: Difference between Noise floor and Max output level (MOL)
Signal to Noise ratio: Difference between nominal level and noise floor
Headroom: difference between nominal level and MOL

Unbalanced signal

- Two wires: hot, carrying signal, and ground
- Advantages:
  - Inexpensive
- Disadvantages:
  - Susceptible to noise
- Shielded unbalances cable
  - Wire mesh tube which encases hot signal, blocking/reducing high frequency interference (guitar cables)
  - Still susceptible to noise, longer cable= more noise

Balanced signals

- Three wire interface: Hot, ground, and cold
  - Hot and Cold 180° out of phase
  - Noise in phase for both signals
  - Subtraction of the two signals results in effectively cancelling noise while simultaneously adding the two signals resulting in twice as large an amplitude, (A-(-A)= 2A)
  - Two popular methods of creating subtraction
    - Op-amps
    - Transformers
- XLRs are most common example of balanced cables.

Dealing with complex numbers

Magnitude $|R| = \text{sqrt}(A^2 + B^2)$
Magnitude squared= $|R^2|= A^2+B^2$
Angle/Argument =$\text{Tan}^{-1}$ (B/A)

Basic electronic components and impedance

- Resistors(R), Capacitors(C), and Inductors (L) all oppose the flow of current, this opposition is called impedance (Z)

<u>Resistor</u>

- Resist (-_-) or oppose the flow of current, absorbing energy from the source by dissipating it as heat
- Resistance or a material is e measurement of its opposition capability in ohms (Ω)
- Oppose AC currents in the same way, regardless of frequency of oscillation
- Most important things about resistors:
  - AC voltage across and current through the resistor are
    - Related linearly by Ohm's Law
    - In phase which each other
- Ohm's law works for all DC and AC voltages and currents:
  - V= IR
- Know series and parallel resistor formulas
- Resistor Voltage Divider
  - $V_{out}= V_{in}(R_2/R_1+R_2)$

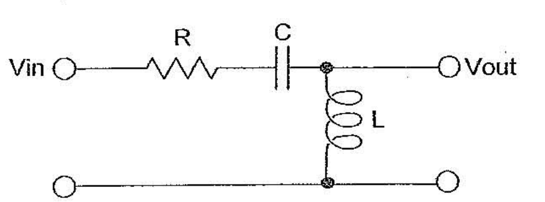
<u>Inductors</u>

- A coil of wire that obeys Faraday's Law: current through a coil of wire create a magnetic field that opposes the current
- Measured in Henrys (H)
- Voltage leads current by 90° phase difference
- L: inductance
- Imaginary number J
  - J=sqrt(-1)
  - $J^2= -1$
  - 1/J= -J
- $Z_L=j\ \omega L$
  - $\omega= 2\pi f$
- At DC= short circuit
- At F=infinity -> open circuit

<u>Capacitors</u>

- Two metal plates separated by a distance, dielectric material in between
- Uses an electric field( not magnetic) to exchange energy with the source
- Measured in Farads (F)
- Current leads voltage by 90° phase difference
- C= capacitance

**2nd Order High-pass Design**




**2nd Order HPF Transfer Function:**

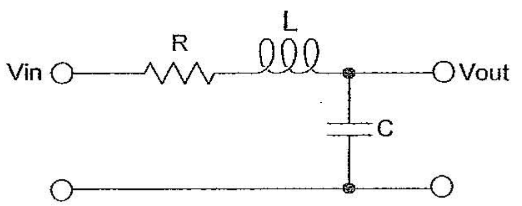
**Design Equations:**

**Specifications: $f_c$, Q**

1. choose L

2. calculate $C = \frac{\left(\frac{1}{2\pi f_c}\right)^2}{\ldots}$

**$2^{nd}$ Order Low-pass Design**




**$2^{nd}$ Order LPF Transfer Function:**

$$H(s) = \frac{1}{(s/\omega_c)^2 + (1/Q)(s/\omega_c) + 1}$$

**where**

$$\omega_c = \frac{1}{\sqrt{LC}}$$

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

**Design Equations:**

**Specifications: $f_c$, Q**

1. choose L

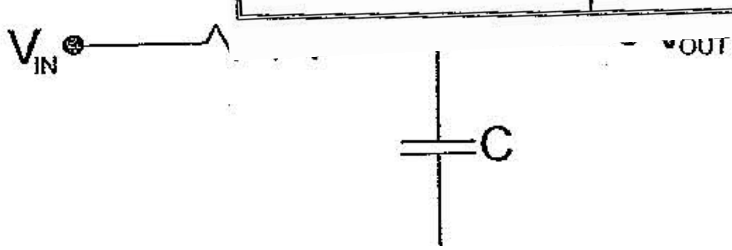
2. calculate $C = \dfrac{\left(\dfrac{1}{2\pi f_c}\right)^2}{L}$

3. calculate $R = \dfrac{1}{Q}\sqrt{\dfrac{L}{C}}$

# Special Names for Q Values

| Q | Name |
|---|---|
| 0.577 | Bessel |
| 0.707 | Butterworth |
| > 0.707 | Chebychev |
| < 0.707 | Over-damped |
| > 0.707 | Under-damped |

# First Or




$$Transfer\ Function = H(j\omega) = \frac{1}{1 + j\omega RC}$$

$$|H(\omega)|^2 = \left(\frac{1}{1+j\omega RC}\right)\left(\frac{1}{1-j\omega RC}\right)$$

$$|H(\omega)|^2 = \frac{1}{1+(\omega RC)^2}$$

$$|H(\omega)| = \frac{1}{\sqrt{1+(\omega RC)^2}}$$

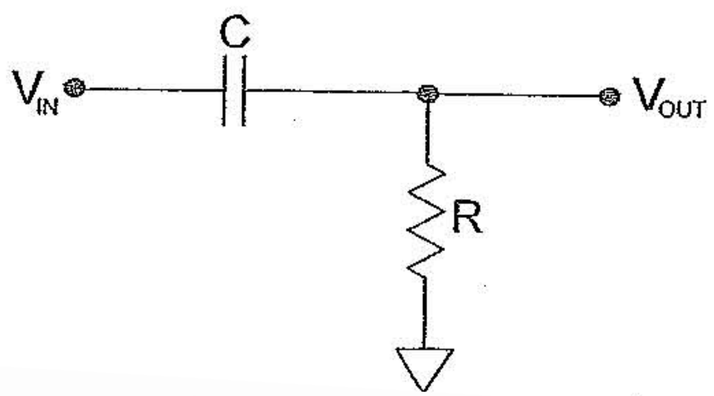
***1st Order LPF Transfer Function***

$$\mathbf{H(s)} = \frac{1}{1 + s/\omega_c}$$

**where**

$$\omega_c = \frac{1}{RC}$$

# First Order High-pass Filter (HPF)




$$|H(\omega)| = \frac{1}{\sqrt{1+\left(\frac{1}{\omega RC}\right)^2}}$$

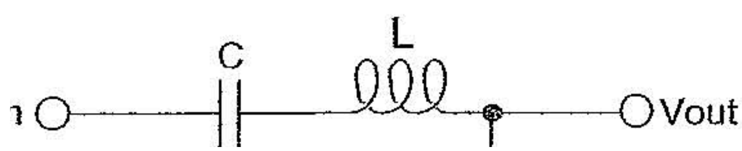
$$f_C = \frac{1}{2\pi RC}$$

***1st Order HPF Transfer Function***

$$\mathbf{H(s)} = \frac{s/\omega_c}{\ldots}$$

# 2nd Order RLC Band-pass Filter

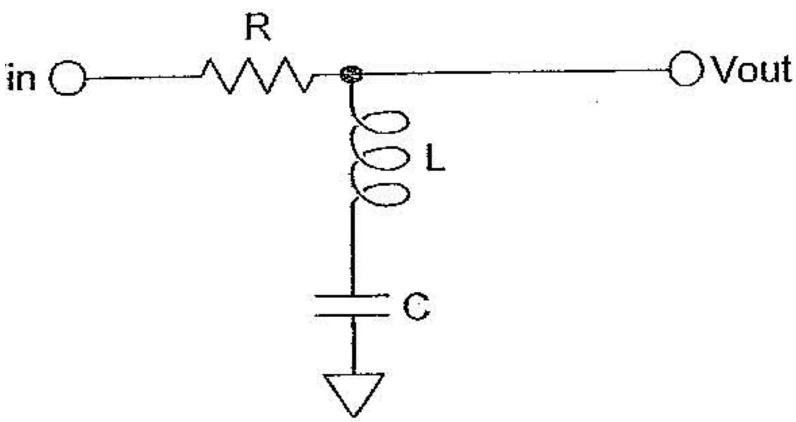
$$\omega_c = \frac{1}{RC}$$




**2nd Order BPF Transfer Function:**

$$\mathbf{H(s)} = \frac{(1/Q)(s/\omega_0)}{(s/\omega_0)^2 + (1/Q)(s/\omega_0) + 1}$$

# $2^{nd}$ Order RLC Band-stop Filter




**$2^{nd}$ Order BSF Transfer Function:**

$$H(s) = \frac{(s/\omega_0)^2 + 1}{(s/\omega_0)^2 + (Q)(s/\omega_0) + 1}$$

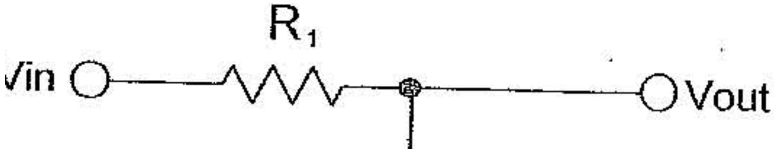
**where**

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{\omega_0}{BW}$$

# Shelving Filters

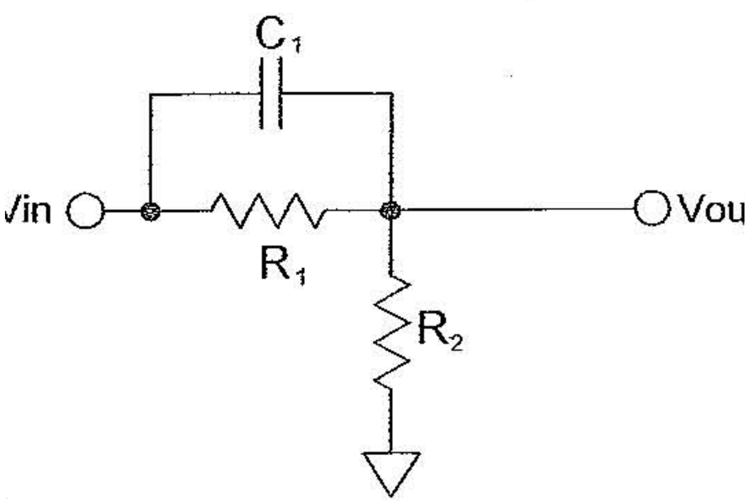
## Low Shelving Filter




**Low Shelving Transfer Function:**

$$H(s) = \frac{1 + (s/\omega_b)}{1 + (s/\omega_u)}$$

# High Shelving Filter




**Low Shelving Transfer Function:**

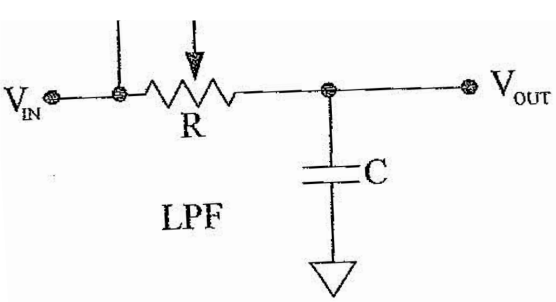
$$\mathbf{H(s)} = \frac{1 + (s / \omega_L)}{1 + (s / \omega_b)}$$

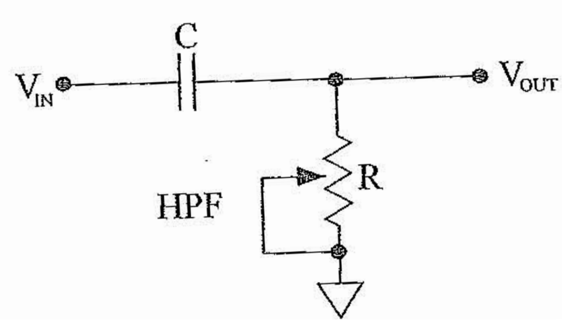
$$f_b = \frac{(R_1 + R_2)}{2\pi R_1 R_2 C_1}$$

$$f_L = \frac{1}{2\pi (R_1 C_1)}$$

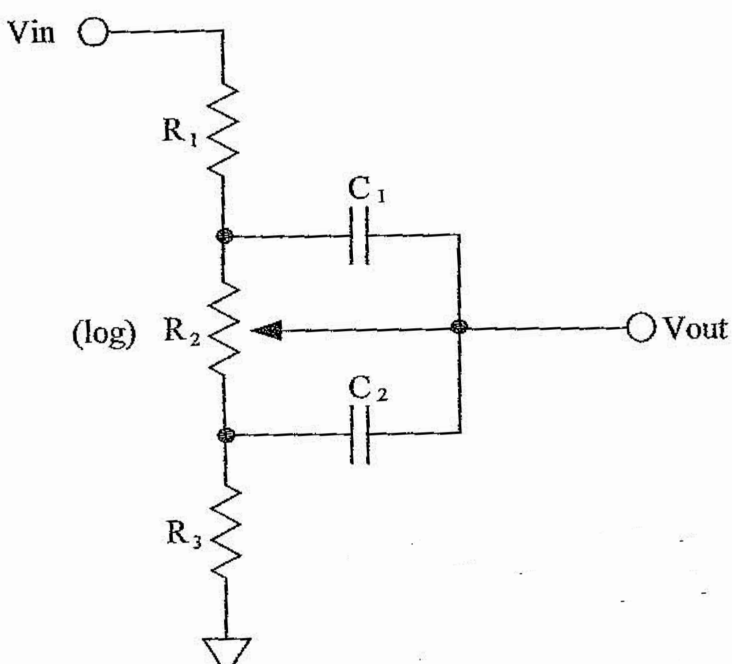
$$ndB = 20 \log\left(\frac{R_2}{R_1 + R_2}\right)$$

# Variable Filters

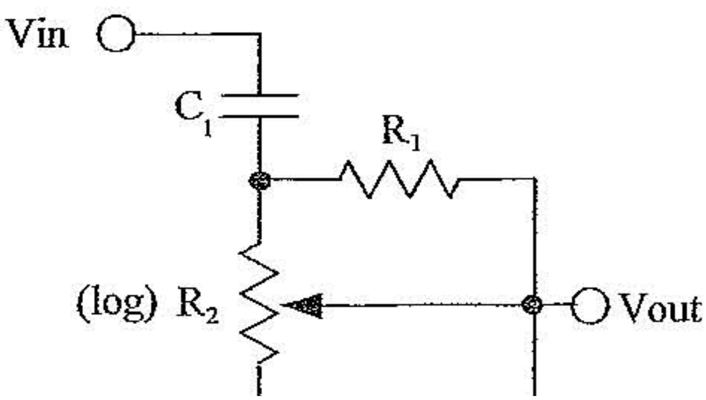


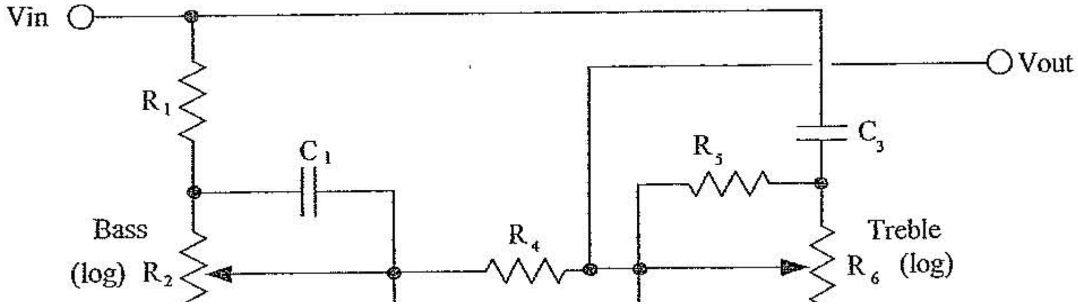
**Variable Low Shelving Filter**



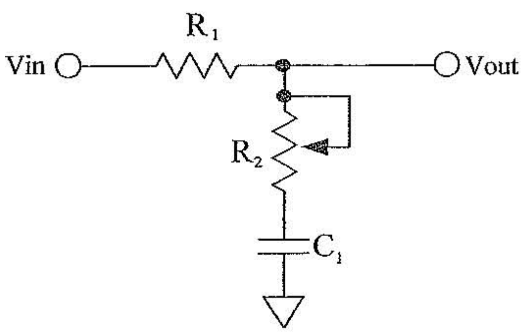

**Variable High Shelving Filter**

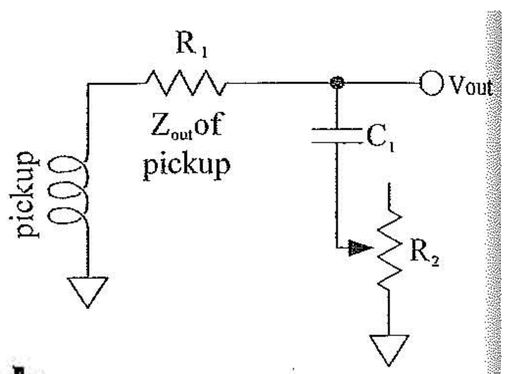



# Band (Combination) Shelving Filter

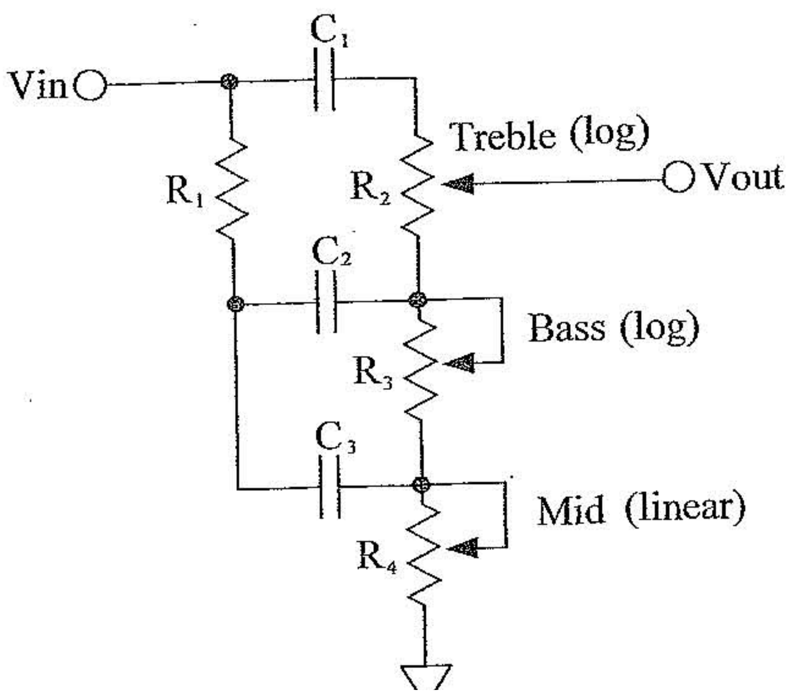


# Guitar and Bass Tone Controls



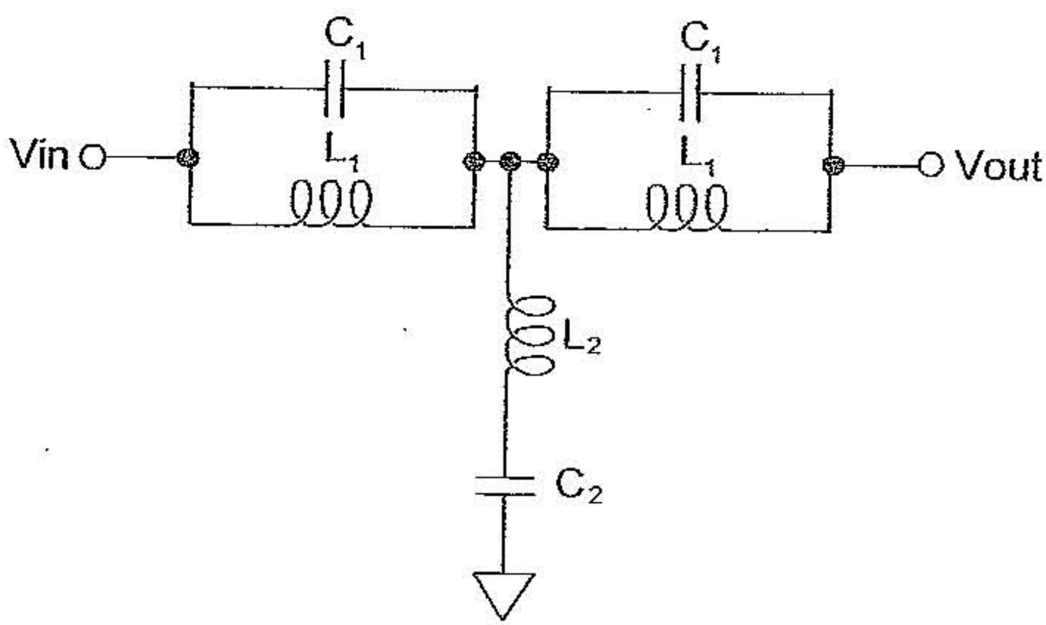



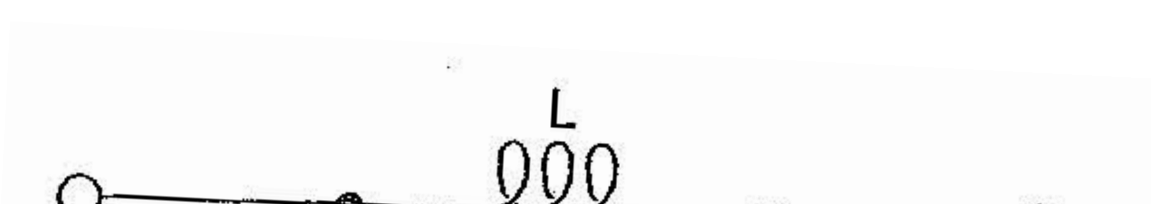

# The Fender® Tone Stack




**Impedance Required)**

## $6^{th}$ Order BSF (Matched Line Impedance Required)



## 3rd Order HPF (Matched Line Impedance Required)