LC Filters

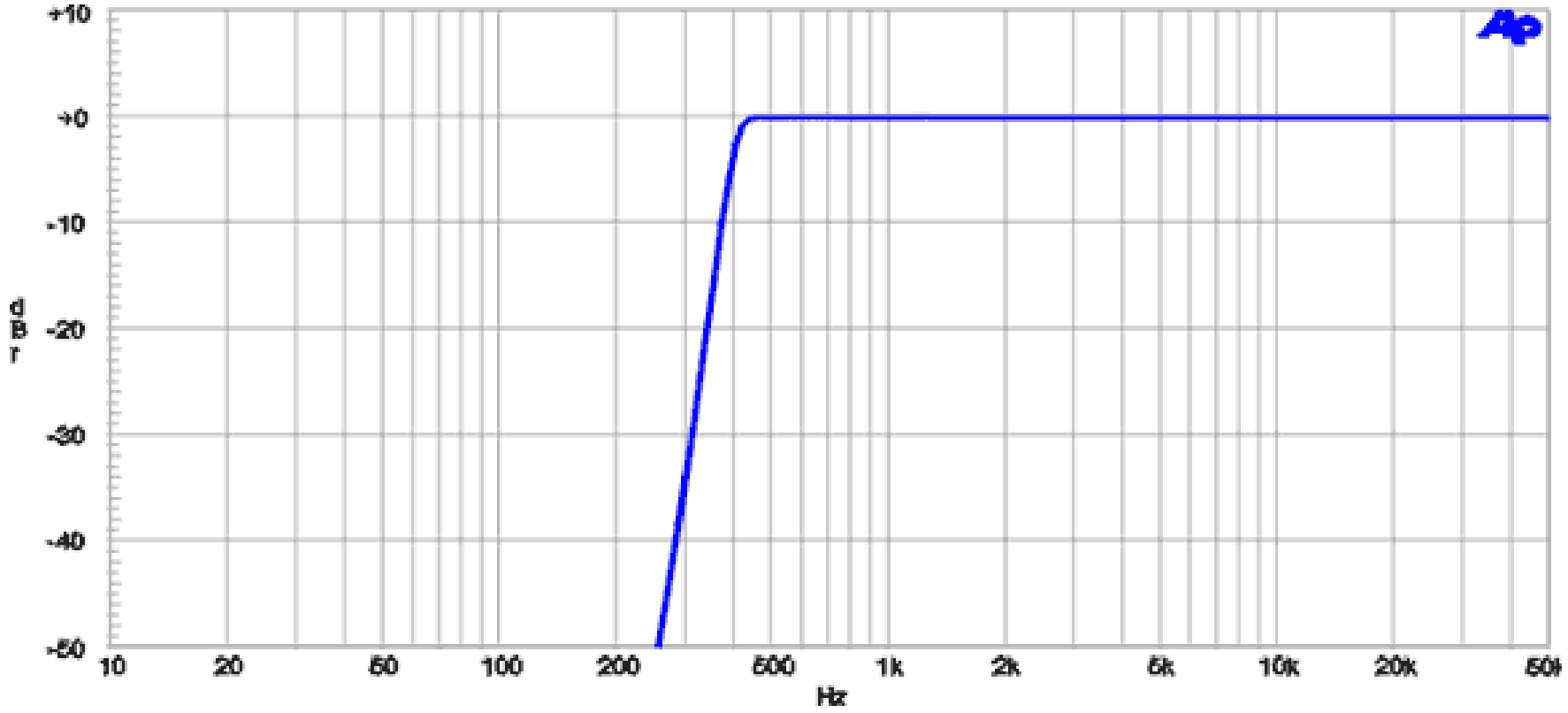
What are filters

- **Filters** will block certain frequencies
- **High Pass Filter** blocks low frequencies and allows high frequencies to pass through
- **Low Pass Filter** blocks high frequencies and allows low frequencies to pass through

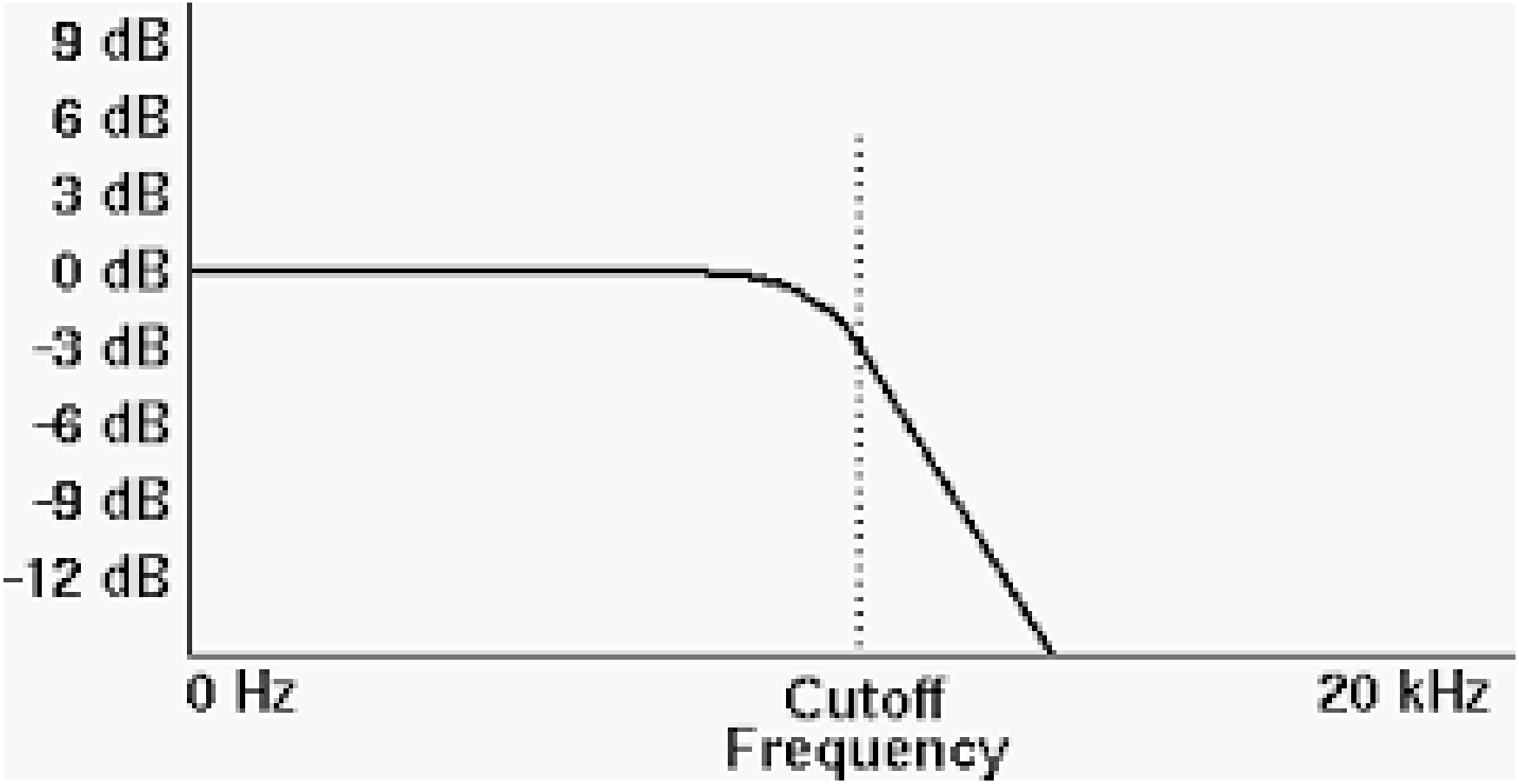
Low Pass Filter Video 8min

- https://www.youtube.com/watch?v=OBM5T5_kgdI

High Pass Filter

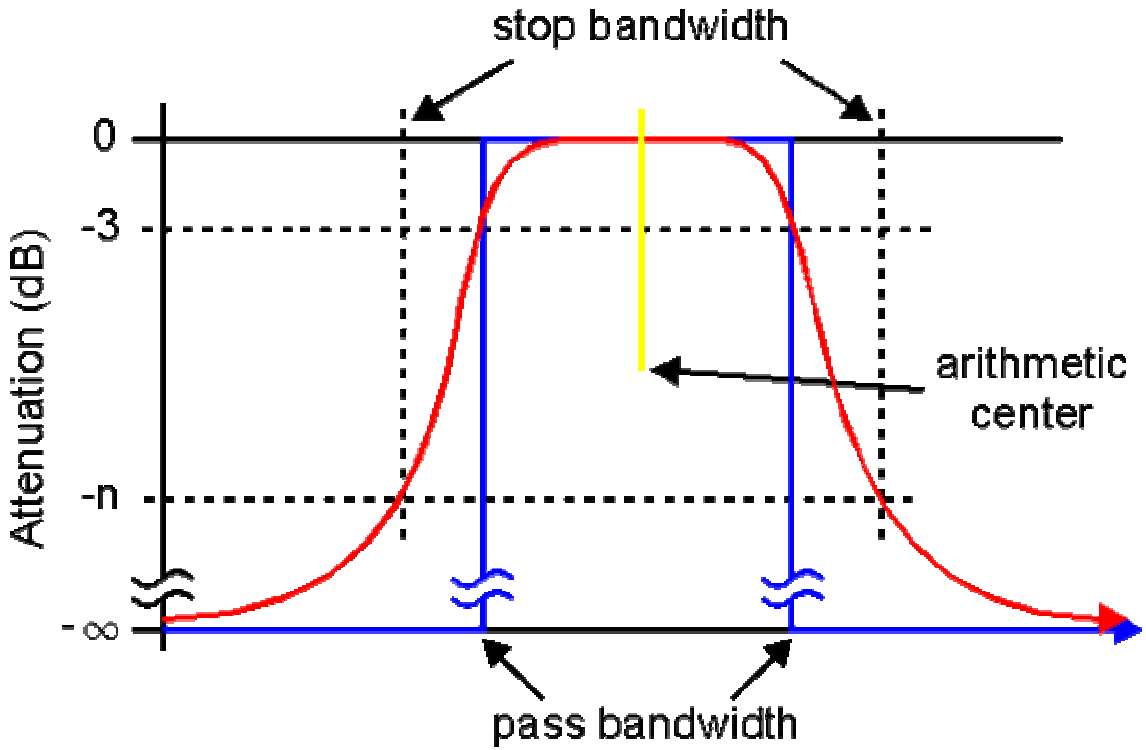


Low Pass Filter



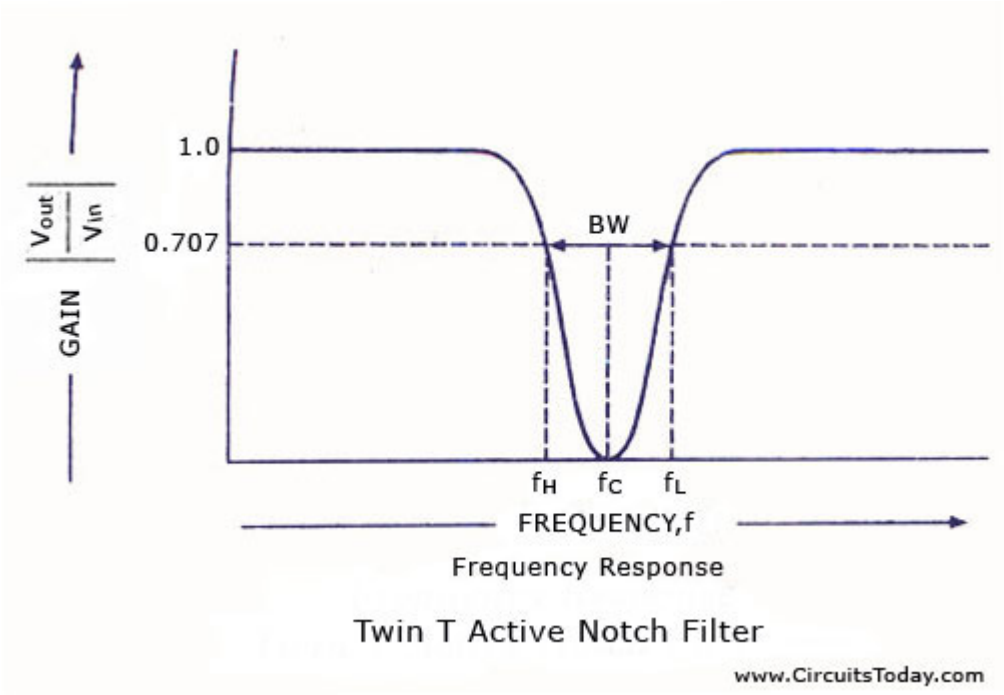
Bandpass Filter

- Rejects frequencies below and above a certain frequency band



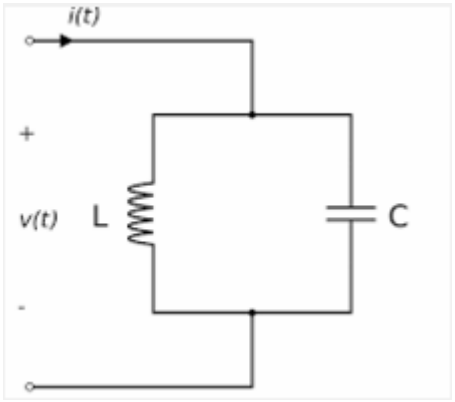
Notch Filter

- Rejects a certain frequency and passes everything else



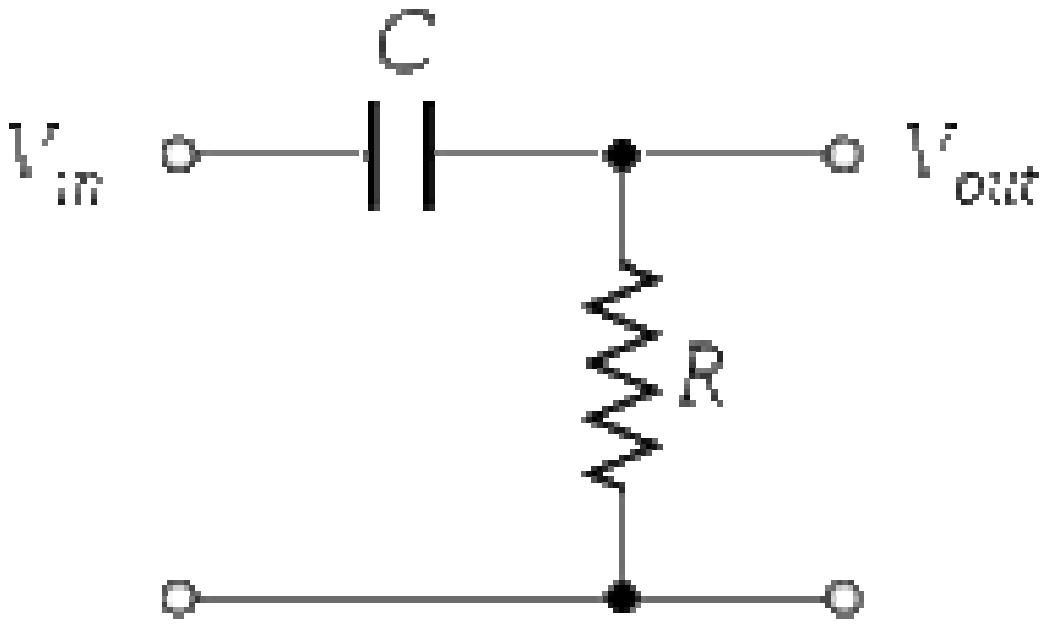
Remember!

- Coils hate change and put up resistance to a changing currents
- Capacitors love change



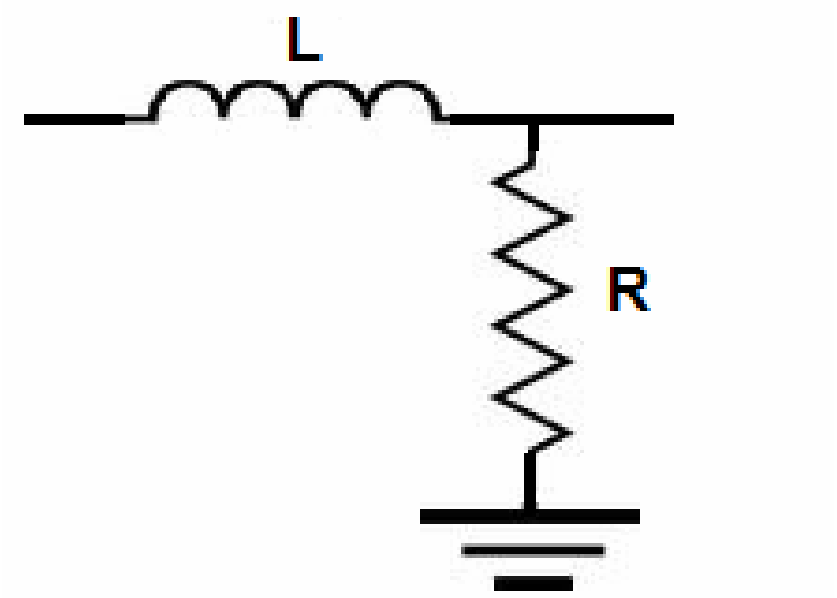
- Coils at high F have a high X or reactance
- Capacitors at high F have a low X or reactance

What does this cct. do?



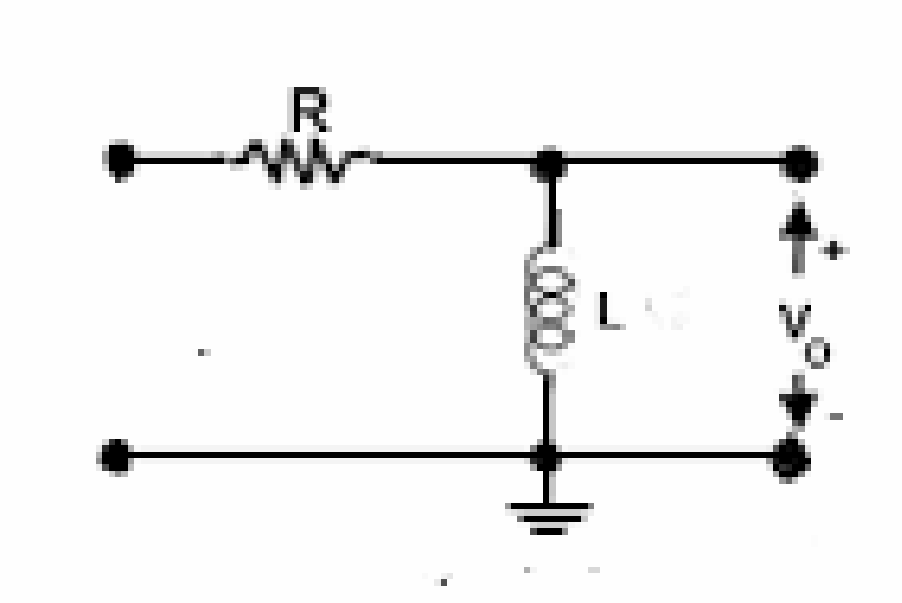
- High Pass Filter

What does this circuit do?



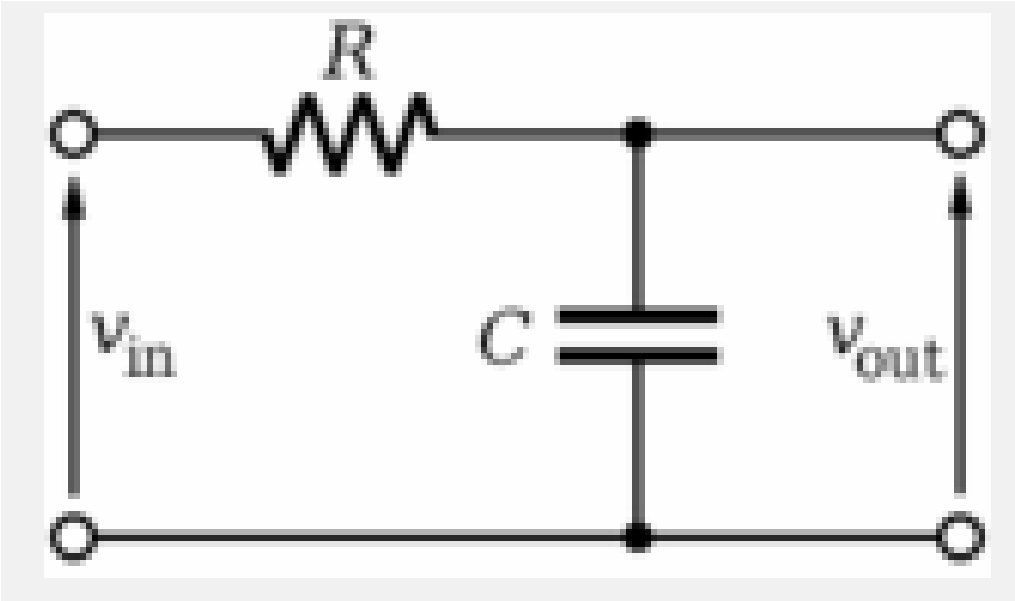
- Low Pass Filter

What type of filter is this?

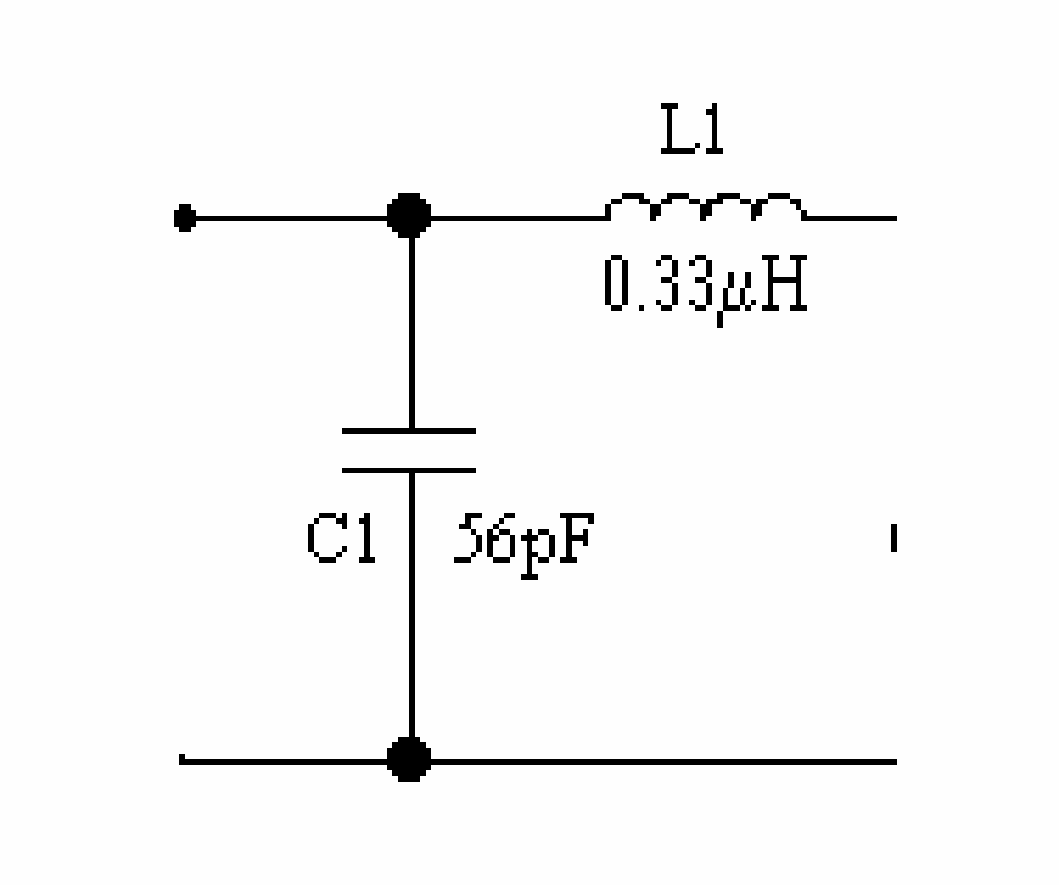


- High Pass Filter

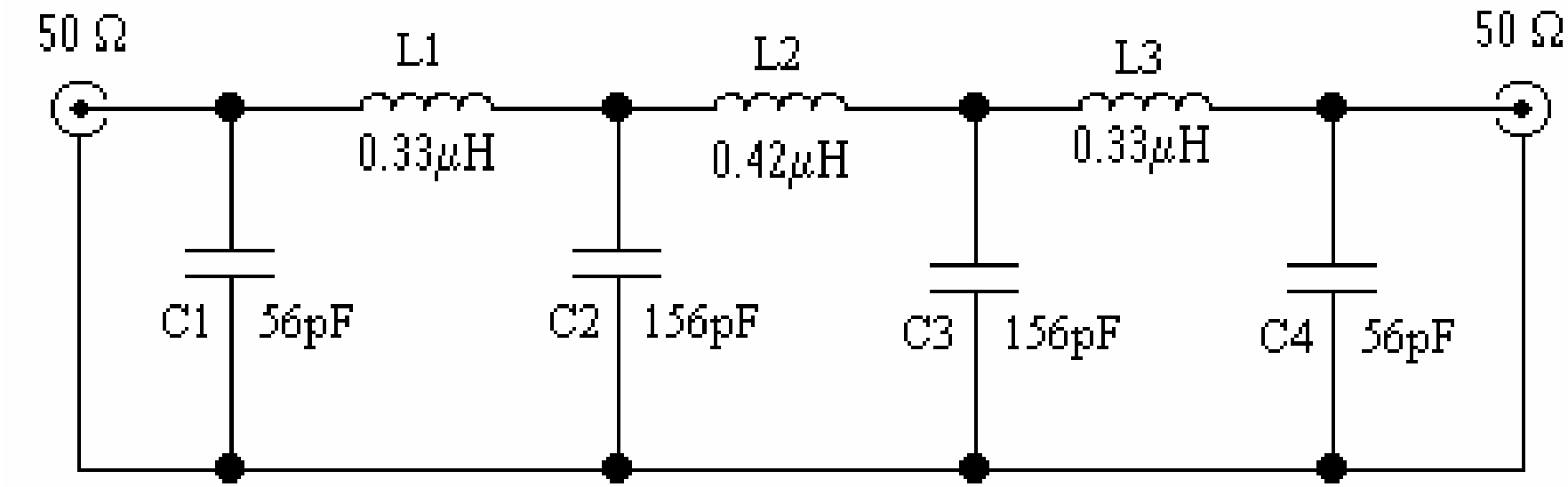
What about this circuit?



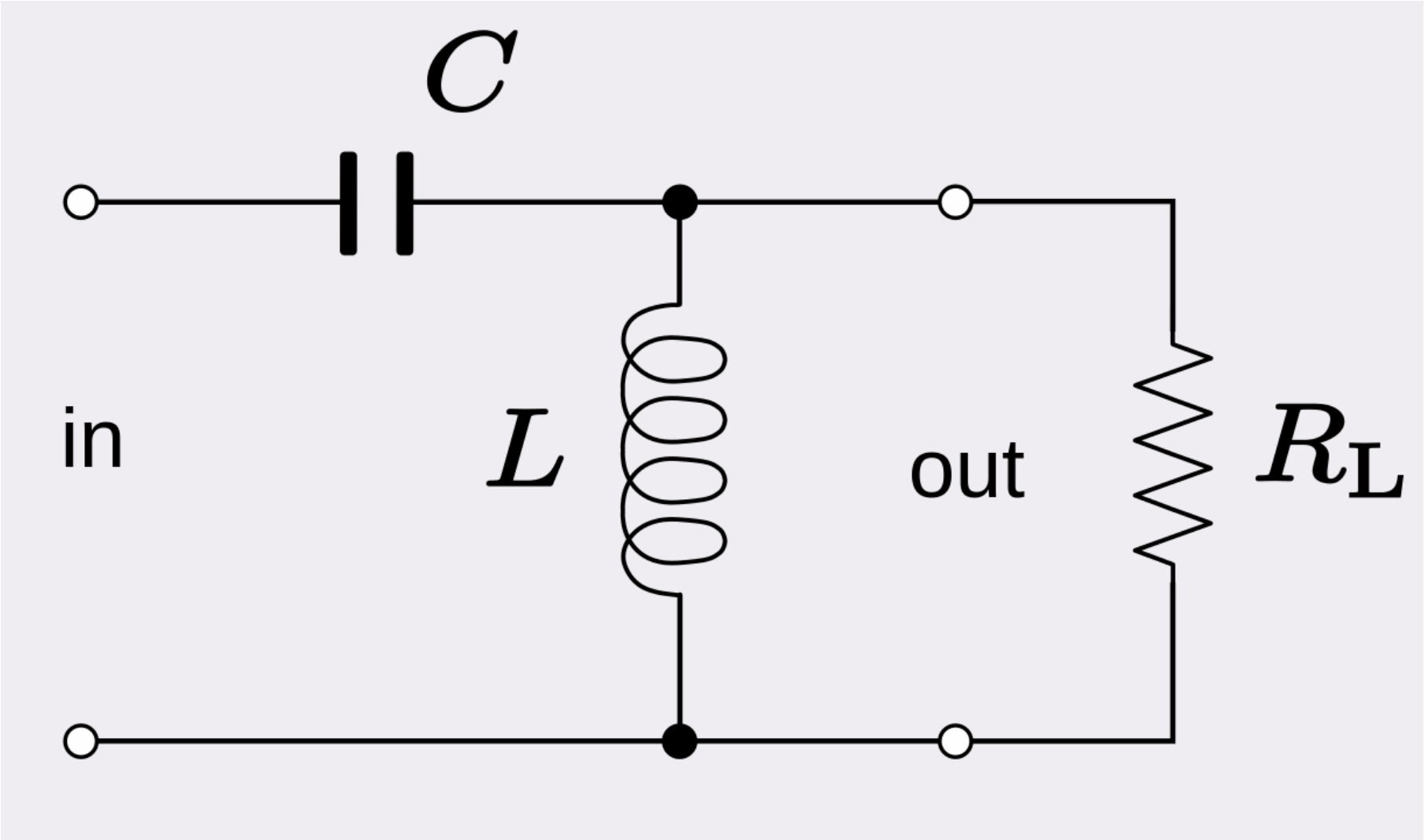
- Low Pass filter



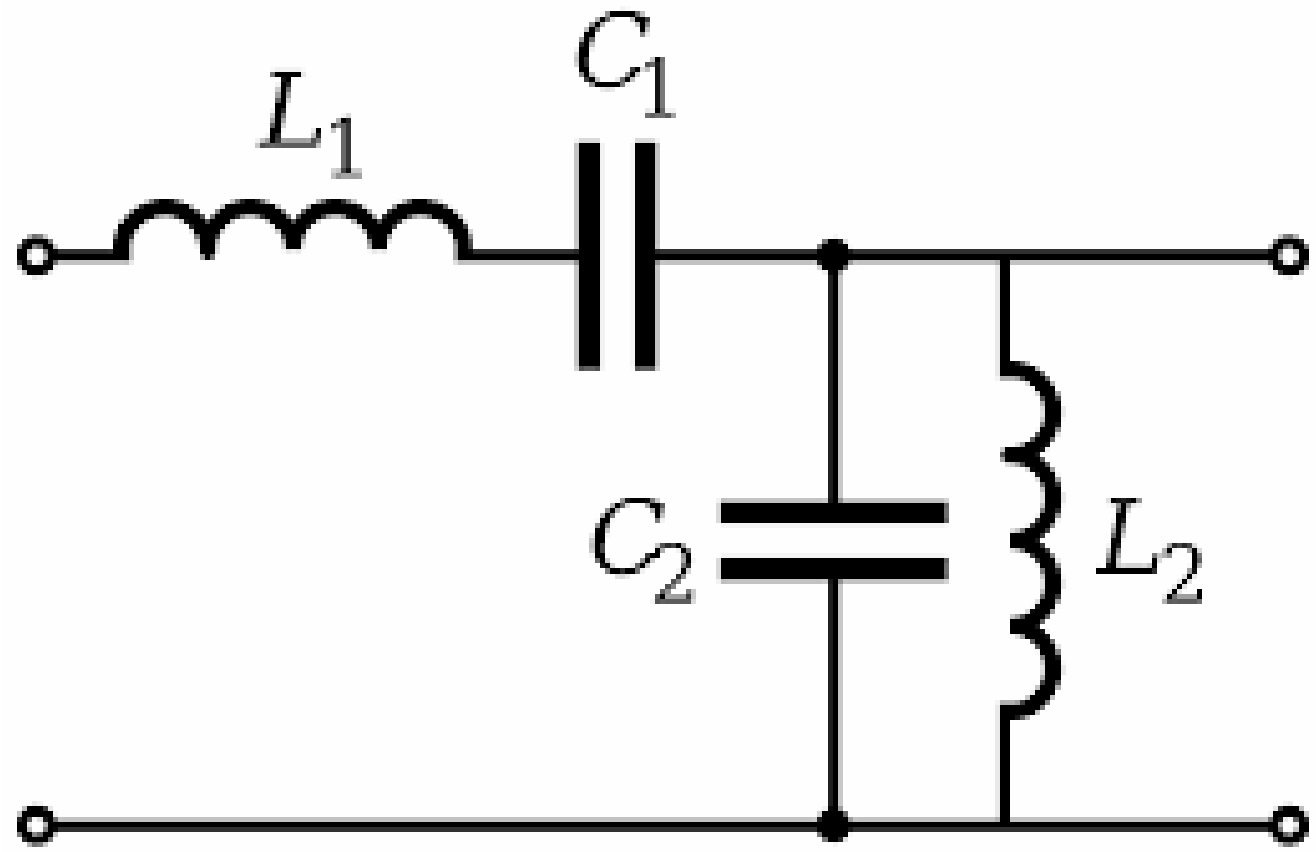
- Low Pass Filter



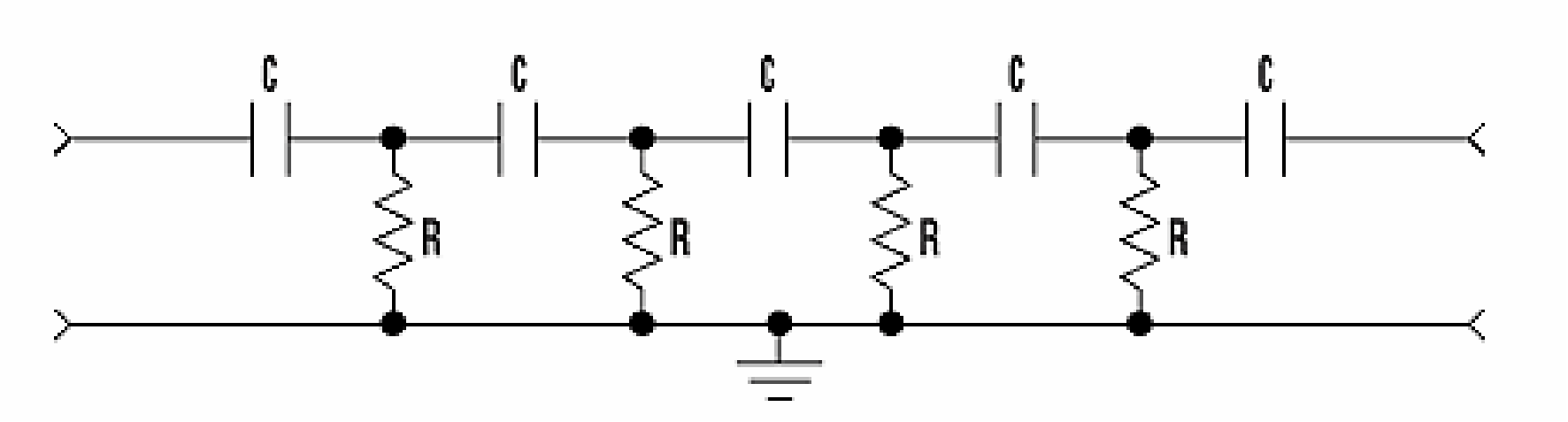
- Low Pass Filters in series



- High Pass Filter

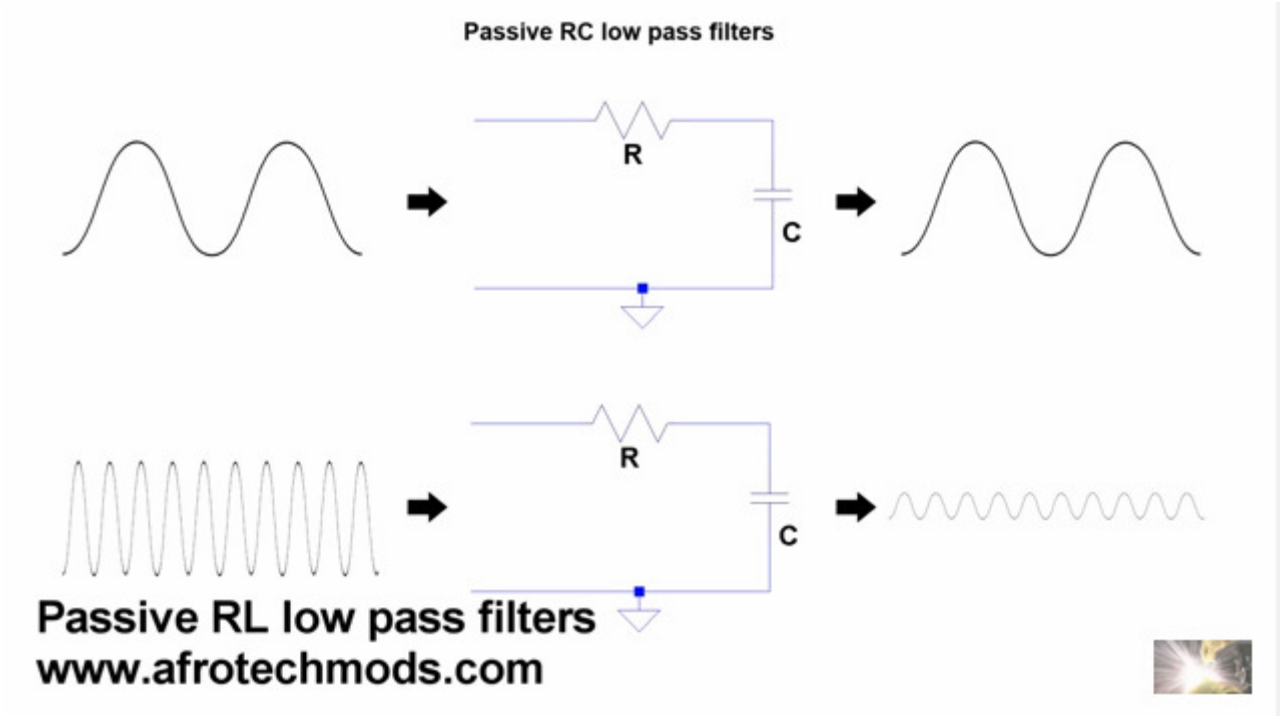


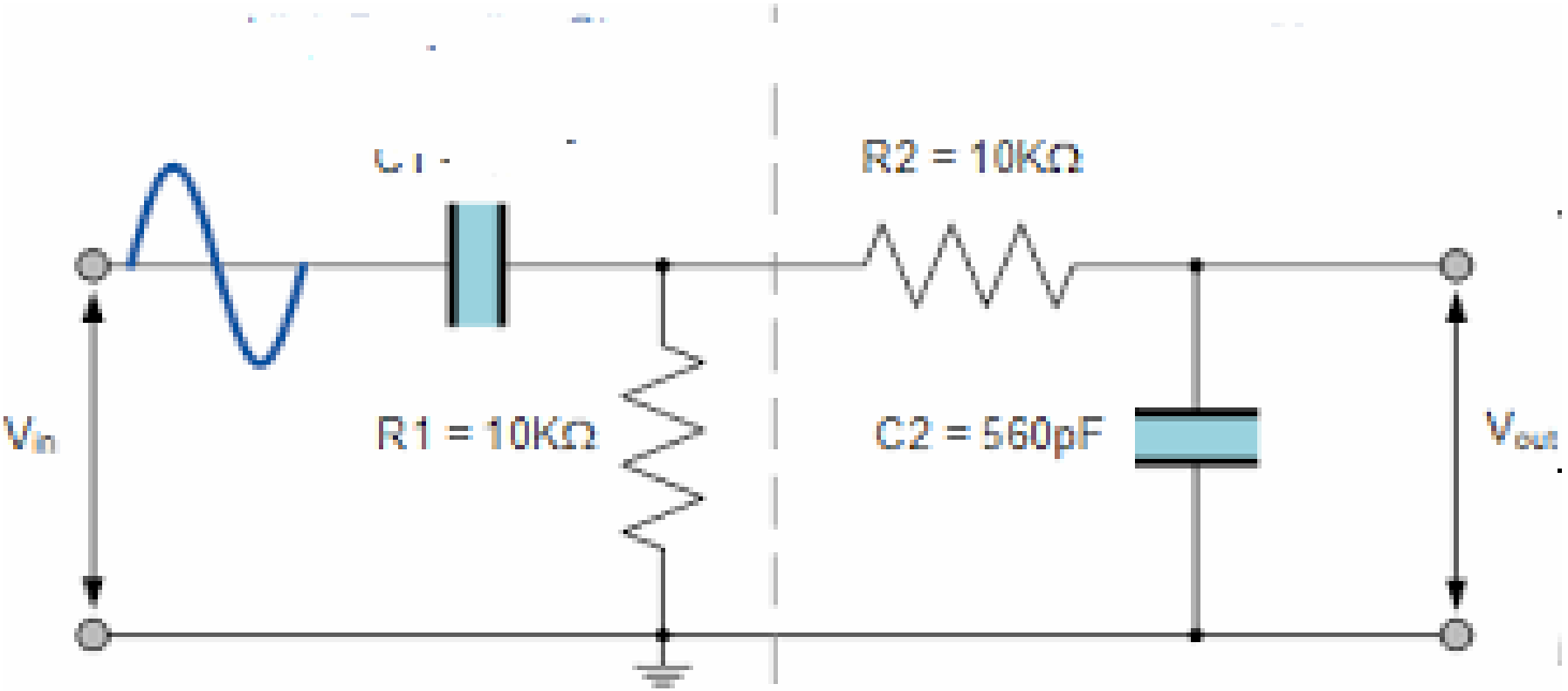
- Band Pass Filter

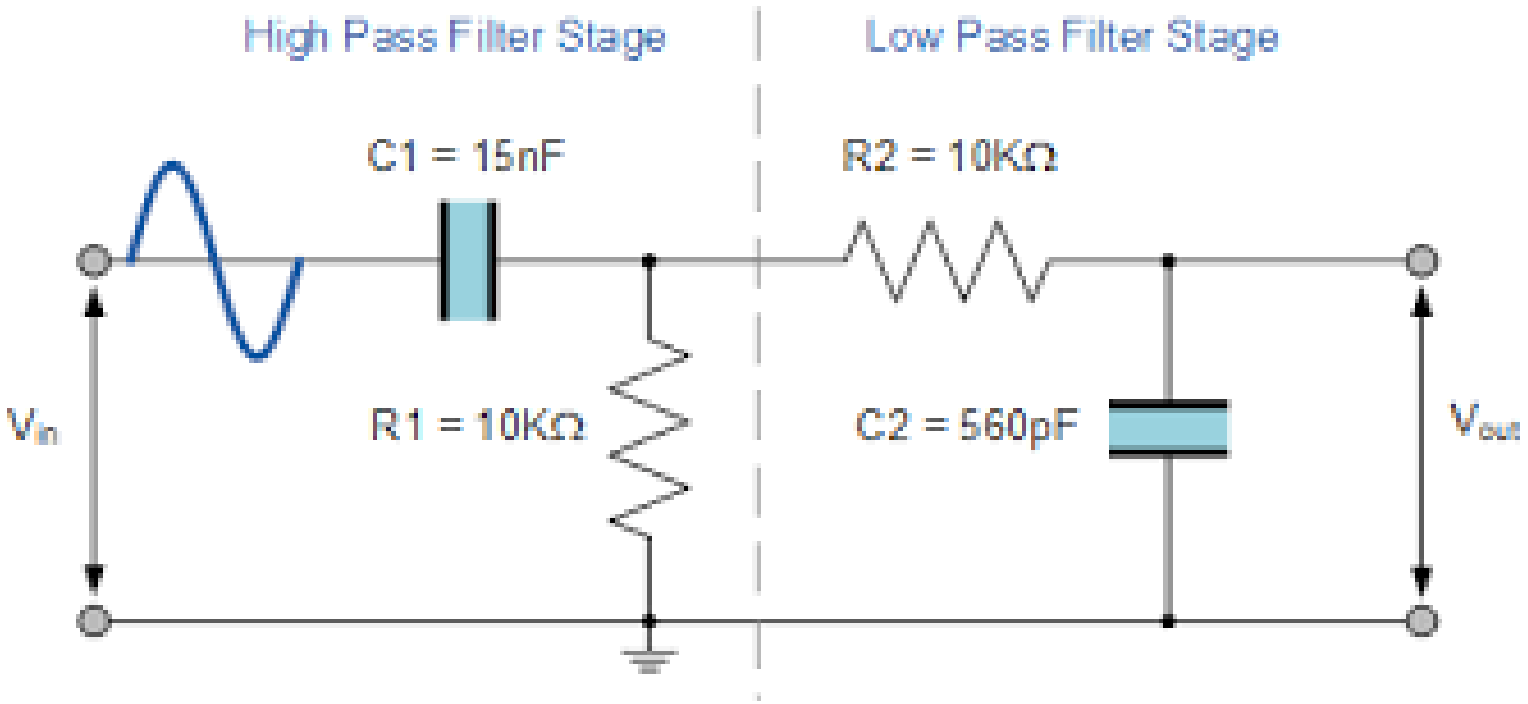


- High Pass Filter

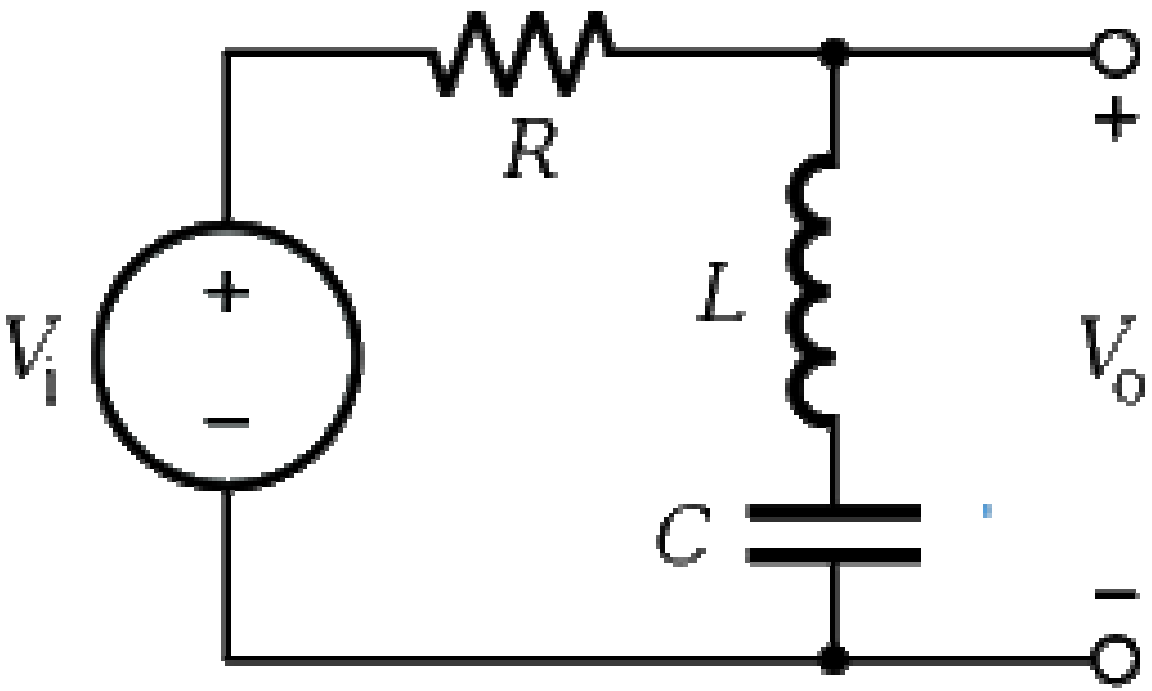
- https://www.youtube.com/watch?v=7jRl_XtyRCo



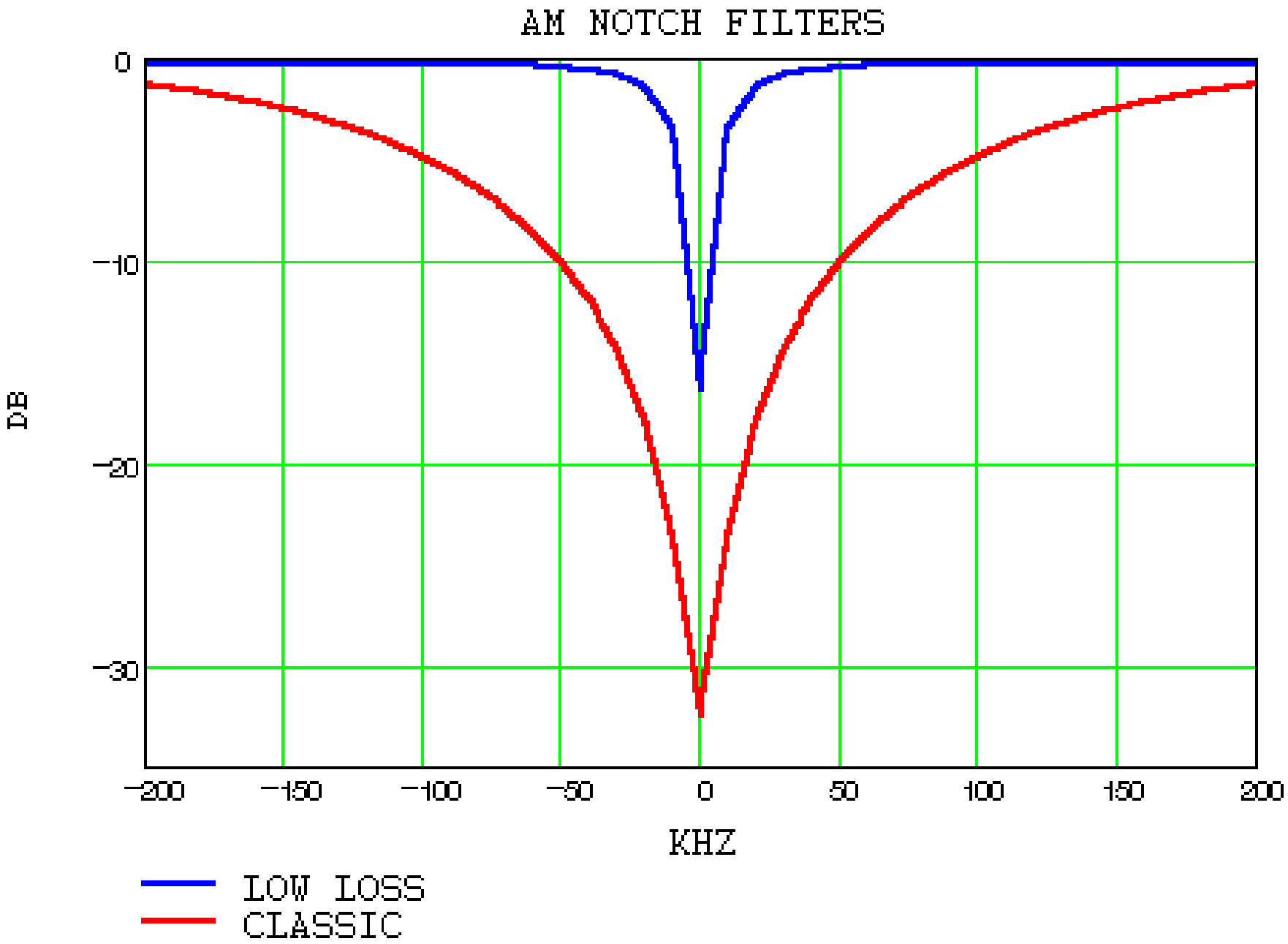

R2 = 10KΩ
R1 = 10KΩ
C2 = 560pF
Vin
Vout

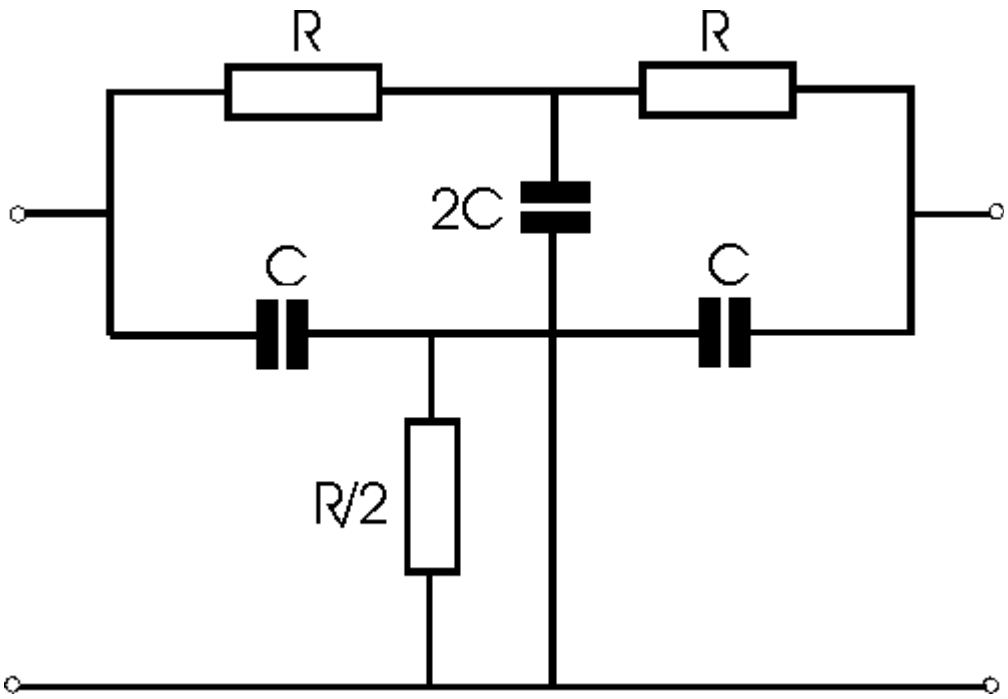


- Band Pass Filter

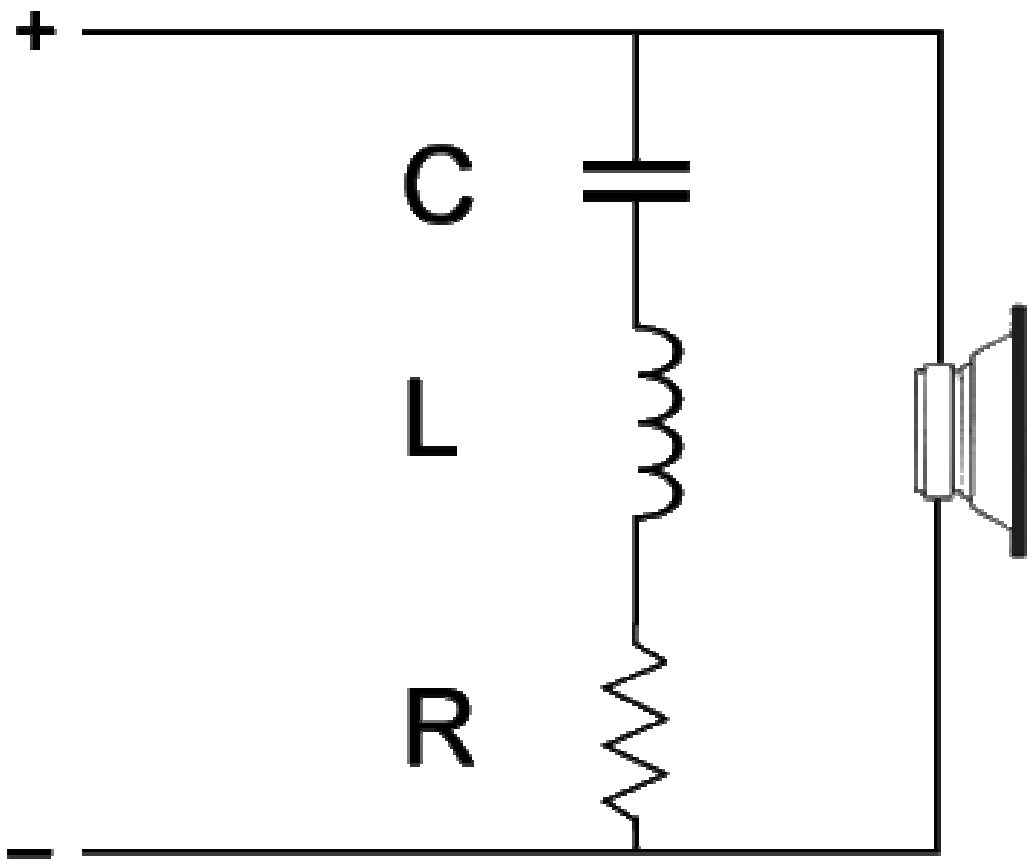


- Notch Filter or Bandstop Filter

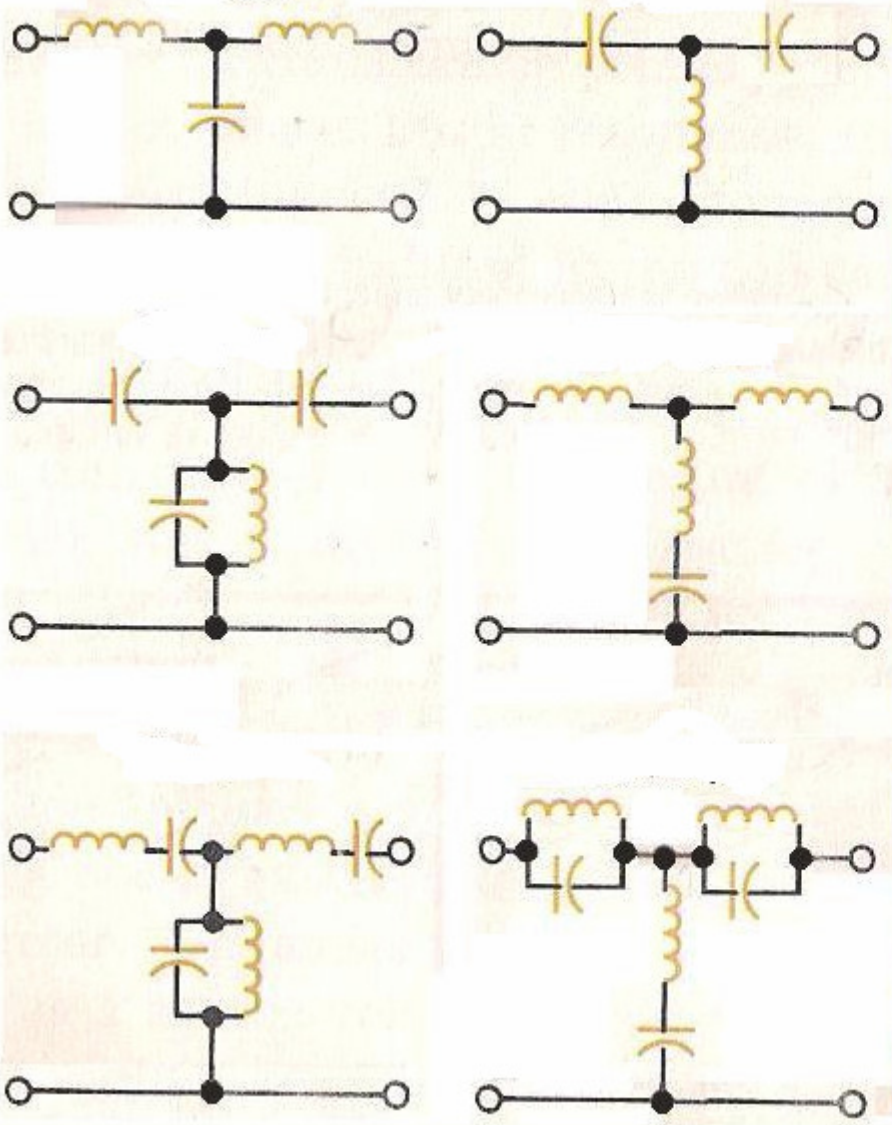

AM NOTCH FILTERS
0
-10
-20
-30
DB
-200
-150
-100
-50
0
50
100
150
200
KHZ
LOW LOSS
CLASSIC



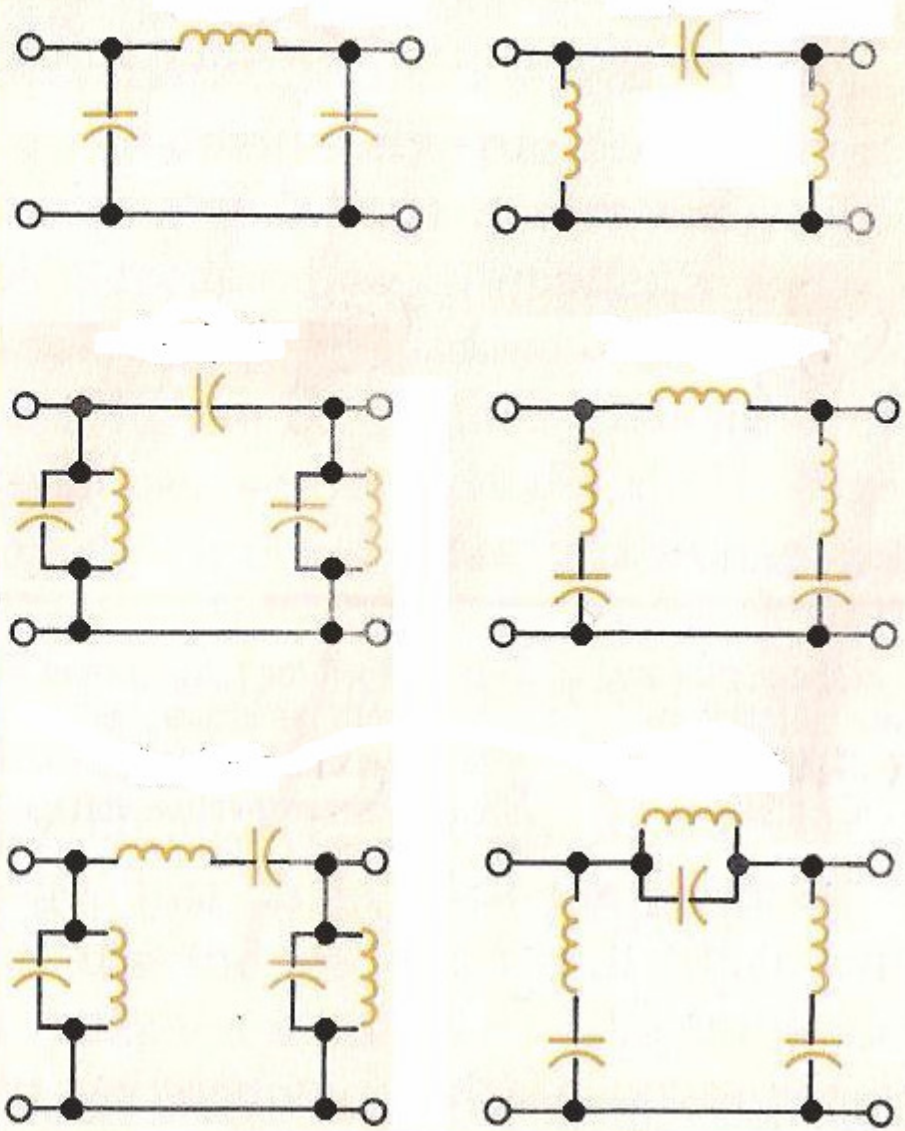
- Twin Notch Filter


+
C
L
R
–

"T " - FILTER NETWORKS

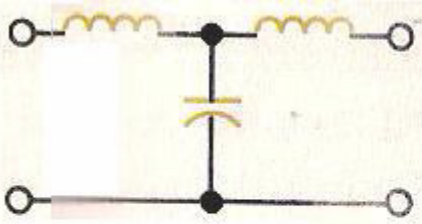


"PI" (π) - FILTER NETWORKS

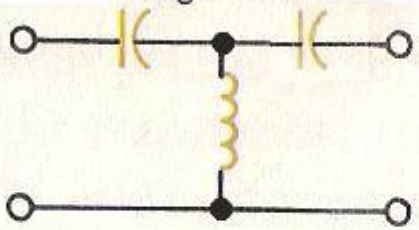


"T " - FILTER NETWORKS

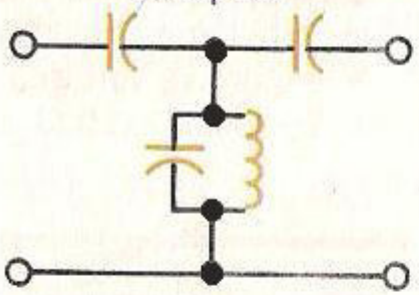
Low-Pass



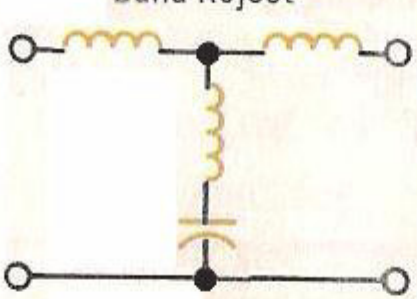
High-Pass



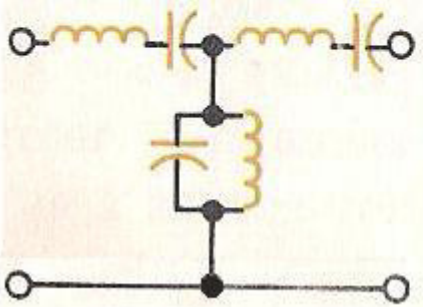
Bandpass



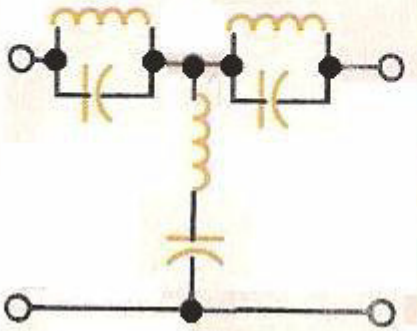
Band-Reject



Bandpass

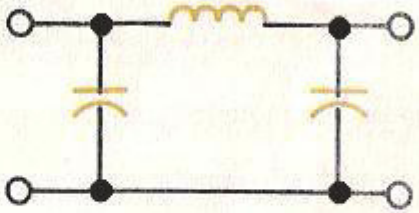


Band-Reject

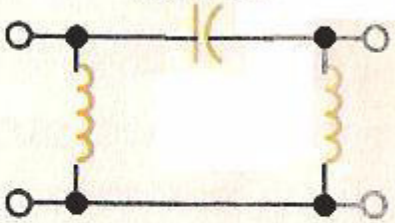


"PI" (π) - FILTER NETWORKS

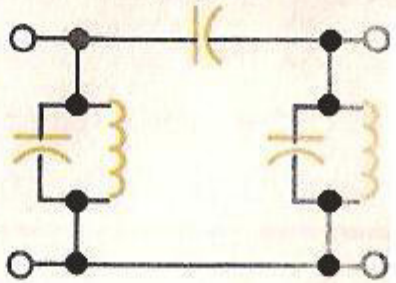
Low-Pass



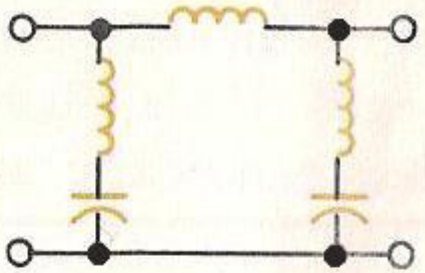
High-Pass



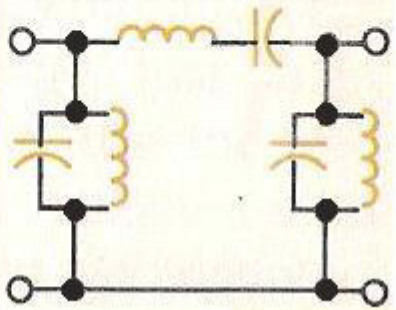
Bandpass



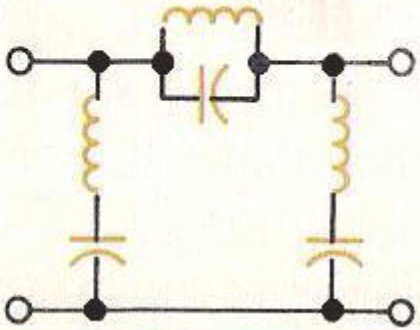
Band-Reject



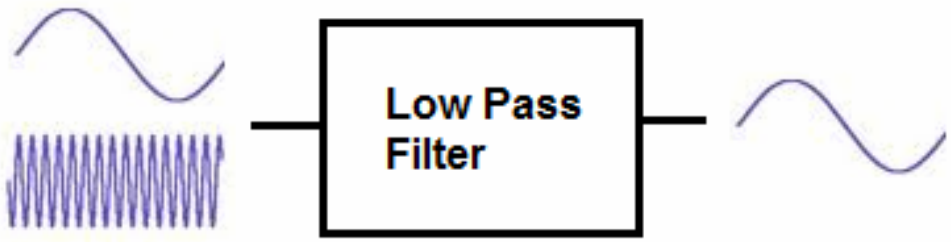
Bandpass



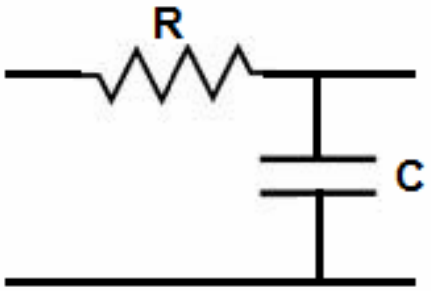
Band-Reject

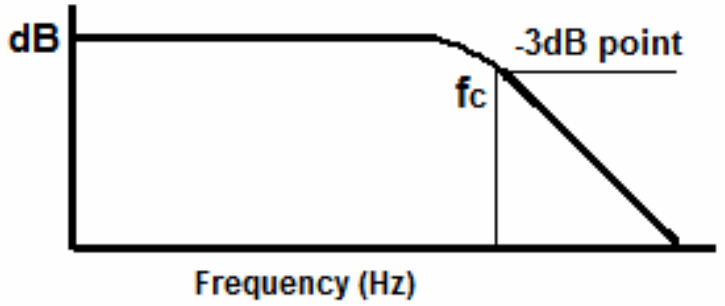


Low Pass Filter Calculations



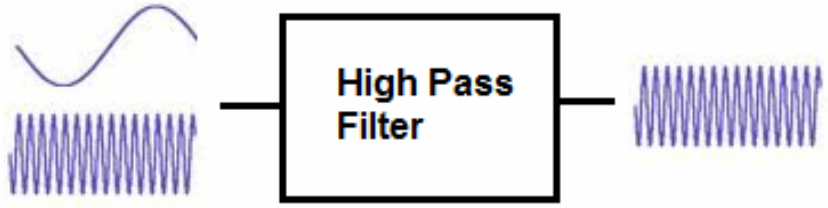
RC Low Pass Filter



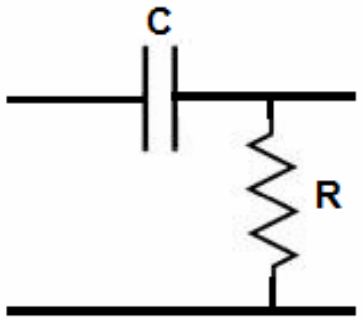


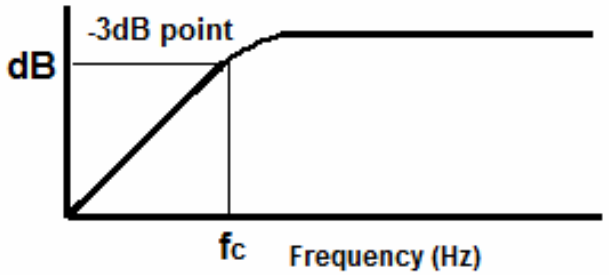
$$f_c = \frac{1}{2\pi RC}$$

High Pass Filter Calculations



RC High Pass Filter

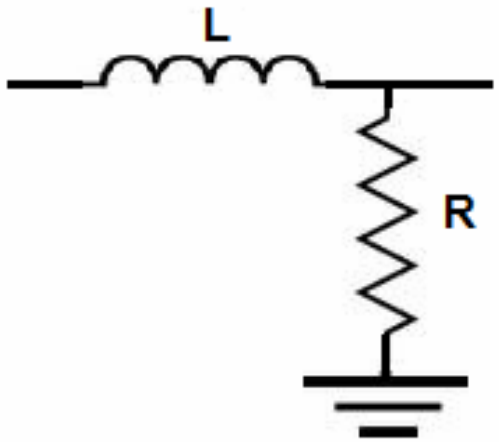


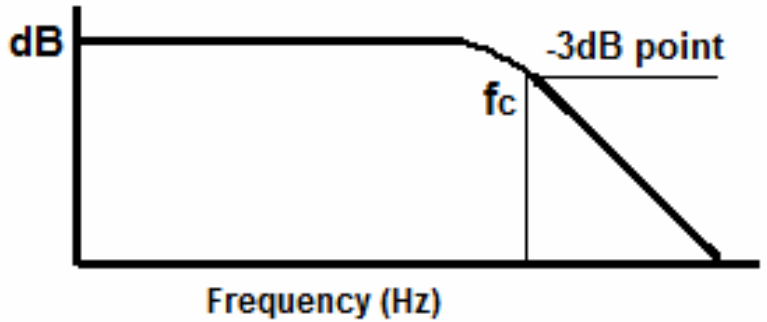


$$f_c = \frac{1}{2\pi RC}$$

RL Filter Calculations

RL Low Pass Filter





$$f_c = \frac{R}{2\pi L}$$

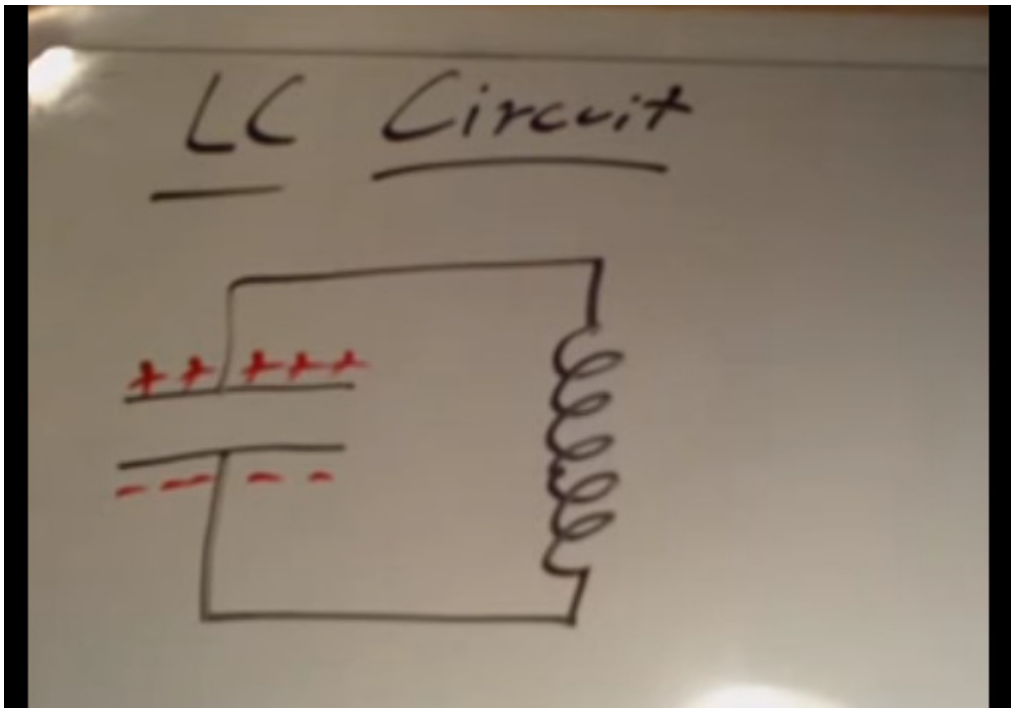
Online Calculator

- Low Pass Filter Calculator
- http://www.learningaboutelectronics.com/Articles/Low-pass-filter-calculator.php

- High Pass Filter Calculator
- http://www.learningaboutelectronics.com/Articles/High-pass-filter-calculator.php

LC Circuits Video 10min

- https://www.youtube.com/watch?v=GTAGqiNLAUY



Task 1:

The PSTN phone system has a frequency range from 300Hz to 3.4kHz. There is a frequency band between 1.1 and 1.2 kHz cut out for phone system control signals.

Design the following filters using capacitors and Resistors:

1. High Pass filters to allow frequencies above 300Hz to Pass

2. Low Pass filter to cut out frequencies above 3.4kHz

3. A notch filter to stop frequencies between 1.1 and 1.2 kHz

- Draw a circuit diagram indicating what type of filtering is provided by the stage
- Calculate component values
  Assume a value of 4.7uF for High Pass filter and 1uF for the Low Pass filter
  Assume a value of 100ohms for the notch filter

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

(R)LC circuit

(a)

$$f_c = \frac{R}{2\pi L}$$

RL circuit

(b)

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

RC circuit

(c)

Task 2:

- For the previous circuit design a filter network consisting of resistors and inductors

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

(R)LC circuit

(a)

$$f_c = \frac{R}{2\pi L}$$

RL circuit

(b)

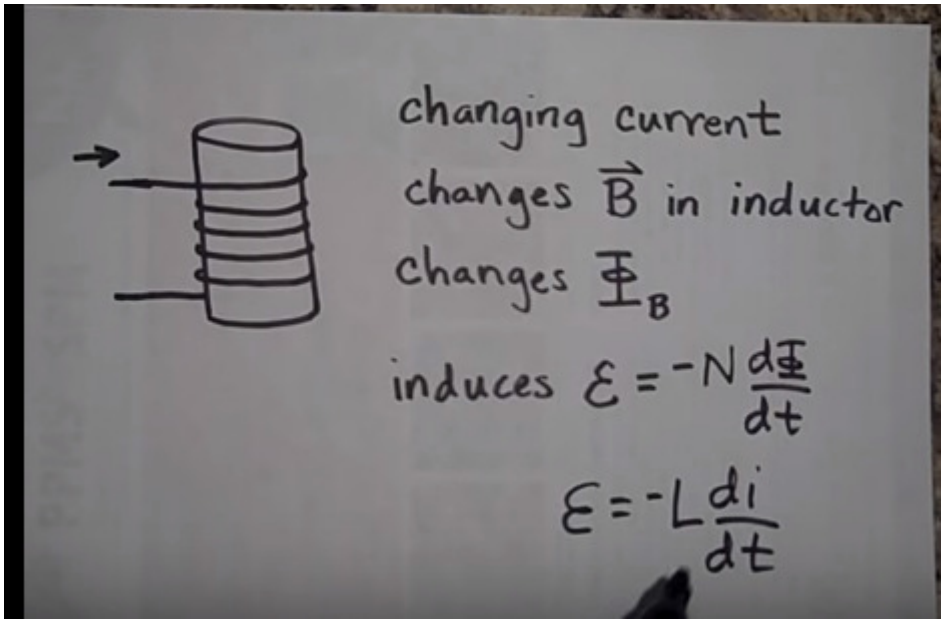
$$f_c = \frac{1}{2\pi RC}$$

RC circuit

(c)

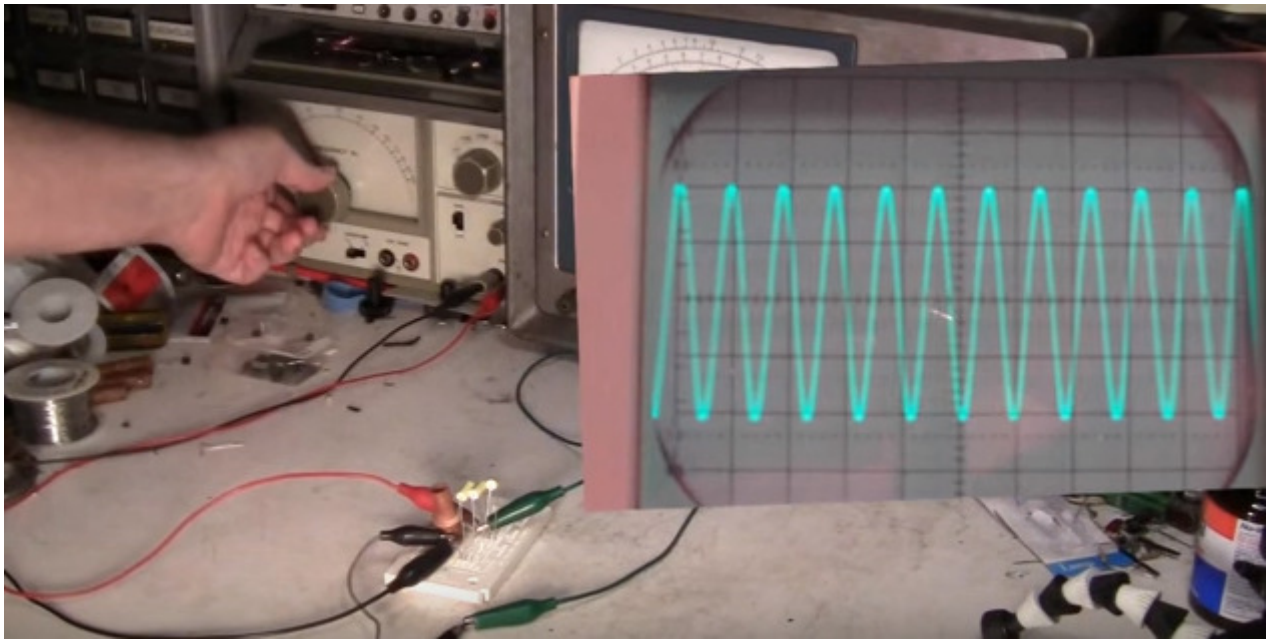
The LC Circuit video (10min)

- https://www.youtube.com/watch?v=v3-HwZMThzQ



Demo on resonance (5min)

- https://www.youtube.com/watch?v=G_RCyDdt2rM



Task 3:

- For the telephone circuit design a filter network using inductor and capacitors

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

(R)LC circuit

(a)

$$f_c = \frac{R}{2\pi L}$$

RL circuit

(b)

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

RC circuit

(c)

Answers:

High Pass Filter

- Fc = 300Hz
- C = 4.7uF (assumed)
- R =
- R = 1/ (2 pie 4.7uF 300Hz)
- R = 112 ohms

Answer

Low Pass Filter

Fc = 3400Hz or 3.4kHz

C = 1uF assumed

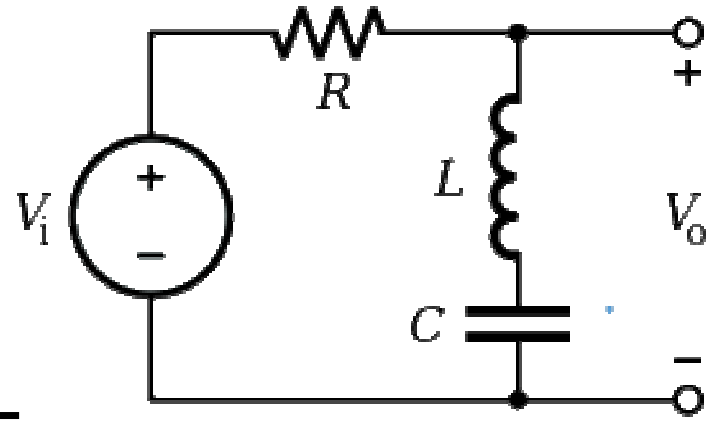
R =

R = 1/ (2 pie 1uF 3400Hz)

R = 46.8 = 47 ohms

Bandstop Filter Answers

- Calculate Fc for HPF using R and L



- Calculate FC for the LPF using R and C
- Use formulas b and c

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

(R)LC circuit

(a)

$$f_c = \frac{R}{2\pi L}$$

RL circuit

(b)

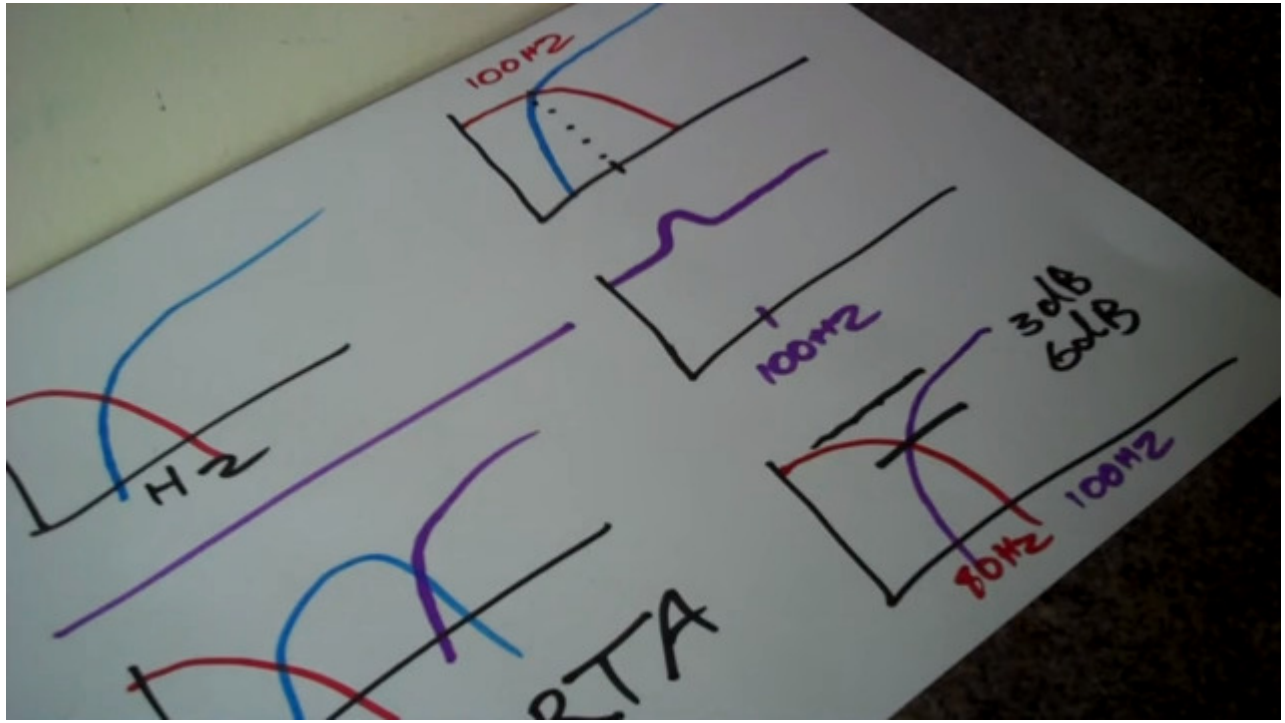
$$f_c = \frac{1}{2\pi RC}$$

RC circuit

(c)

Speaker filter design – Video (7min)

- https://www.youtube.com/watch?v=iqgIUI-YN1I



Task – a 3-Way Speaker

- You are designing a loudspeaker system consisting of a bass, mid range speaker and a tweeter
- Built three filter networks to cover the Low, Mid and High ranges
- Built an RC network use 1uF capacitors. Draw a cct. for each speaker

	Frequency Range	What type of sounds
Very Low	under 30Hz	Bottom notes on a pipe organ, rumble of explosion - Subwoofer only
Low	30Hz to 160Hz	Bass Tuba, Bass Guitar - Woofer
Mid	160Hz to 3kHz	Human voice, Trumpet, Sax - Woofer or Midrange
High	3kHz to 20,kHz	Cymbals, Piccolo - Tweeter

Built the speaker filters using inductors

- Built three filter networks to cover the Low, Mid and High ranges
- Built an RC network use 1mH inductors. Draw a cct. for each speaker

	Frequency Range	What type of sounds
Very Low	under 30Hz	Bottom notes on a pipe organ, rumble of explosion - Subwoofer only
Low	30Hz to 160Hz	Bass Tuba, Bass Guitar - Woofer
Mid	160Hz to 3kHz	Human voice, Trumpet, Sax - Woofer or Midrange
High	3kHz to 20,kHz	Cymbals, Piccolo - Tweeter

Built the cct. Using LC

- Built three filter networks to cover the Low, Mid and High ranges
- Built an LC network use 1mH inductors. Draw a cct. for each speaker

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

(R)LC circuit

	Frequency Range	What type of sounds
Very Low	under 30Hz	Bottom notes on a pipe organ, rumble of explosion - Subwoofer only
Low	30Hz to 160Hz	Bass Tuba, Bass Guitar - Woofer
Mid	160Hz to 3kHz	Human voice, Trumpet, Sax - Woofer or Midrange
High	3kHz to 20,kHz	Cymbals, Piccolo - Tweeter

Crossover design for real – Video

(7min)

- https://www.youtube.com/watch?v=S56gT_-8ML8