Basic reference materials

Horowitz P., Hill W.: Art of Electronics,
Cambridge University Press 1989

Other reference materials

Taur. Y., Ning T.: Fundamentals of Modern VLSI Devices,
Cambridge University Press 1998

Form of assessment

Written examination (60%)
Laboratory assessments (40%)

Course coordinator

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http://fiona.dmcs.pl/~piotrowi-> Electronics Fundamentals

LECTURE

Lecture focused on introducing the fundamental electronics concepts, devices and circuits with emphasis on interfacing with computer systems.

Electronic devices (diodes, BJT and FET transistors)
Basic circuits (amplifiers, rectifiers, semiconductor switches, drivers for LEDs, voltage and current sources)
Basic MOS gates.
Computer simulation of electronic circuits based on SPICE software.

LABORATORY

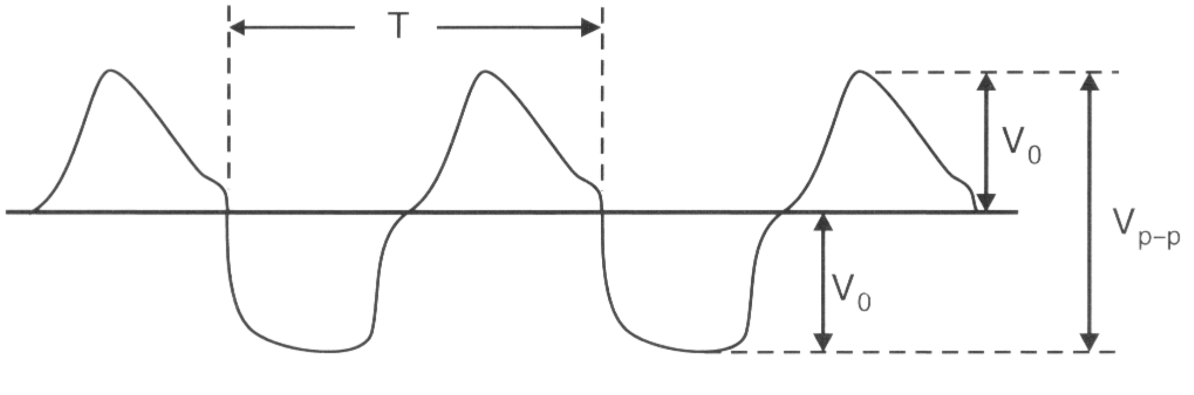
1. Using the measurement equipment - 2h
2. Diode characteristics (junction d., Zener, LED) - 2h
3. Half- and full-wave rectifiers - 2h
4. Configuration of operational amplifier - 2h
5. MOS characteristics - 2h
6. CMOS logic gates - 2h
7. Application of SPICE simulator - 4h

ELECTRONICS

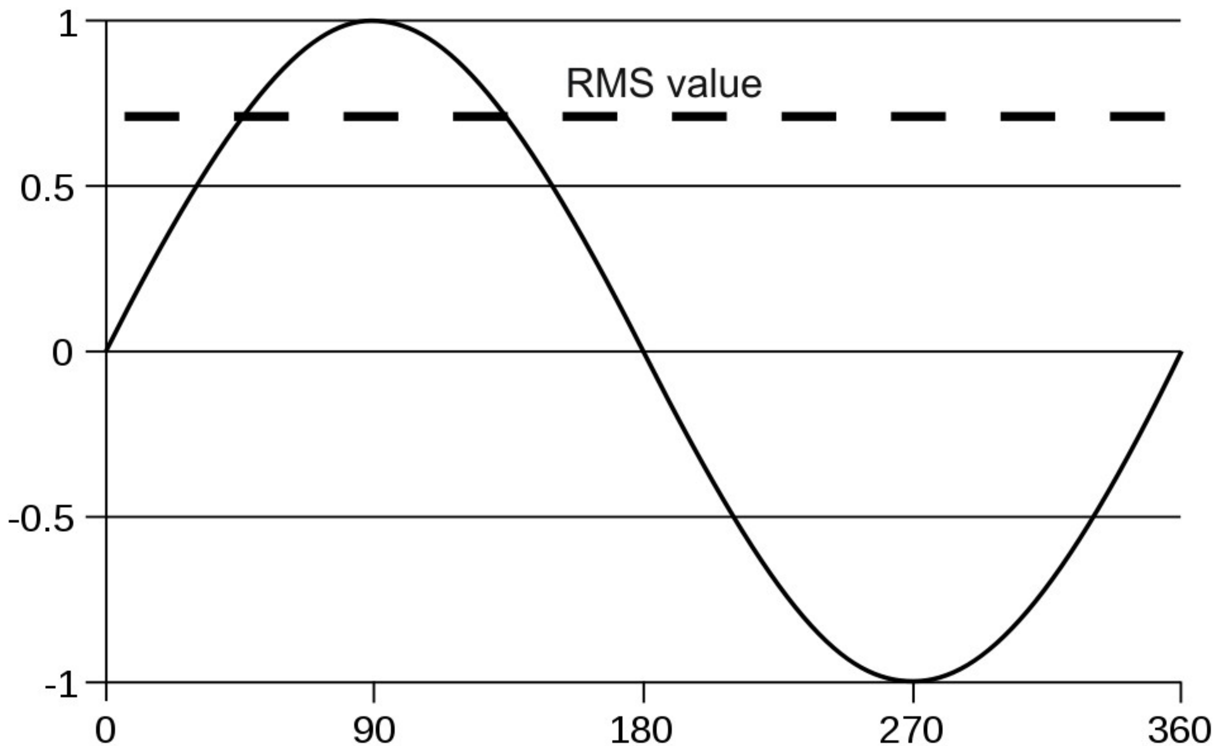
branch of science and technology which makes use of the controlled motion of electrons through different media and vacuum. The ability to control electron flow is usually applied to information handling or device control.

Electrical science and technology – deals with the generation, distribution, control and application of electrical power.

Until 1950 electronics was called "radio technology" because its principal application was the design and theory of radio transmitters, receivers and vacuum tubes.



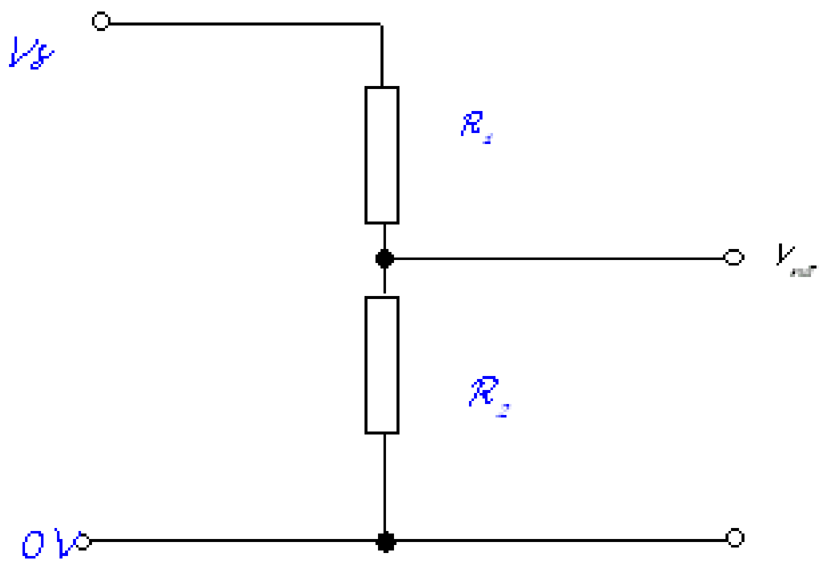
Representation of an arbitrary, periodic waveform



$$A_{RMS} = \frac{A_p}{\sqrt{2}}$$

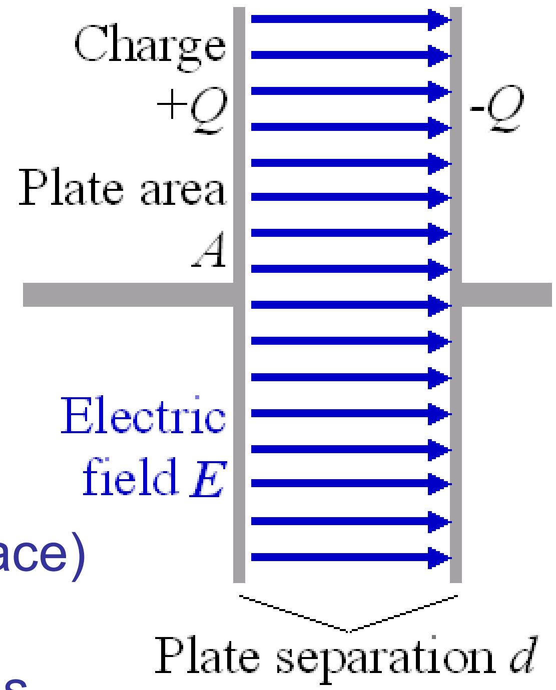
Alternating signal (sinusoidal) and its RMS value

Voltage divider



$$V_{out} = V_{in} \cdot \frac{R_2}{R_1 + R_2}$$

Capacitors



$$C = k\varepsilon_0 A/d$$

Where:

ε_0 = 8.854x10^{-12} F/m (permittivity of free space)

Farad = coulomb per volt,

k – dielectric constant of insulating materials,

A – conductor area

d – thickness of separation layer

$$Q = C \cdot V$$

Some typical dielectric materials used in capacitors

Material	Dielectric constant (κ)
Vacuum	1.0
Air	1.0054
Paper	3.5
Mica	5.4
Ceramic	100

AC analysis:

$$V(t) = V_0 \sin(\omega t + \phi)$$

$$if \quad t = 0 \qquad V(0) = V_0 \sin\phi$$

$$Q = C \cdot V$$

$$I = \frac{dQ}{dt} = C\frac{dV}{dt} = C\frac{d}{dt}\left(V_0 \sin\omega t\right) =$$

$$\omega C V_0 \cos\omega t = \omega C V_0 \sin\left(\omega t + 90^0\right)$$

For a capacitor the current **leads** the voltage by 90^0

$$V_C = I_C \cdot X_C$$

Where $X_C = 1/\omega C$ is the capacitive reactance

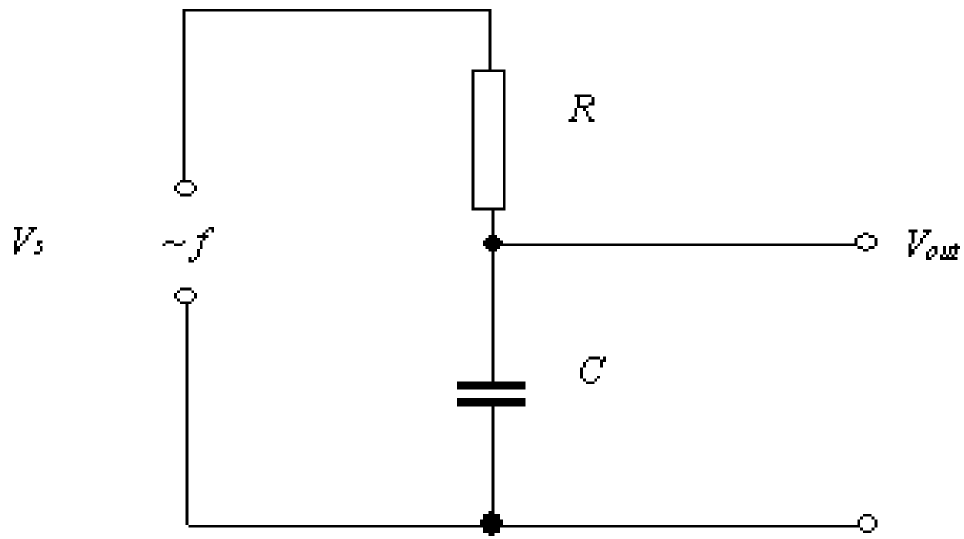
Inductors

For an inductance the current **lags** the voltage by 90^0

$$V_L = L \frac{dI_L}{dt} \qquad V_L = I_L \cdot X_L \qquad X_L = \omega L$$

Passive circuits

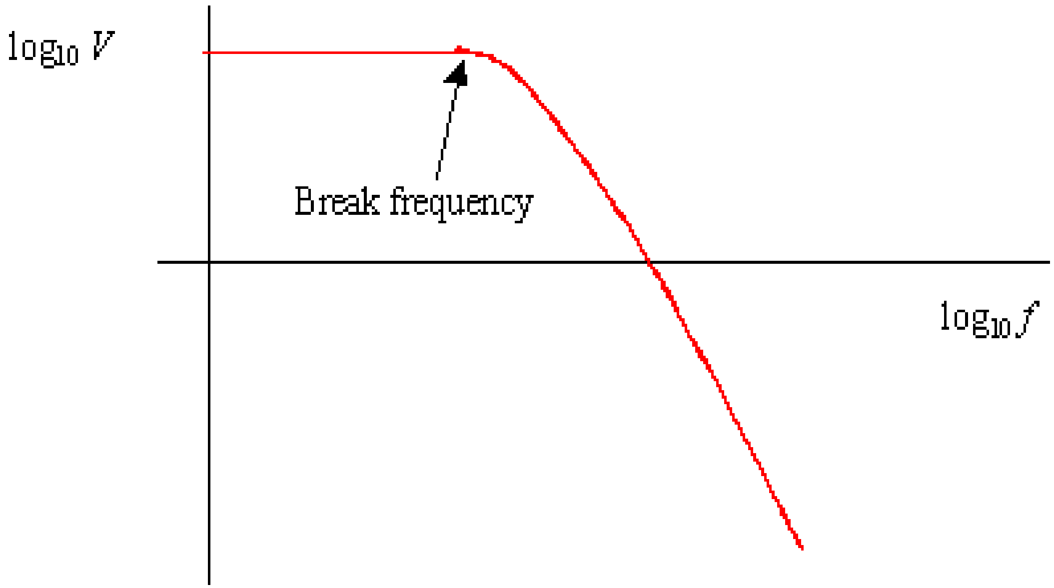
Low-pass filter



break frequency

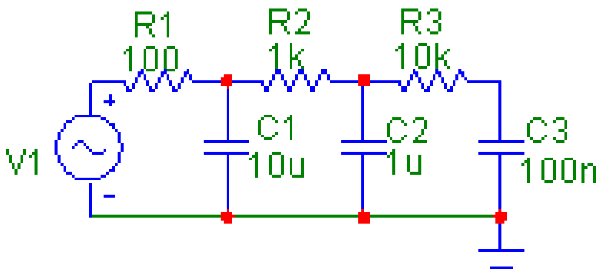
$$f_b = \frac{1}{2\pi RC}$$

Filter characteristics



We can measure the voltage across the capacitor at different frequencies and plot the log of the voltage against the log of the frequency.

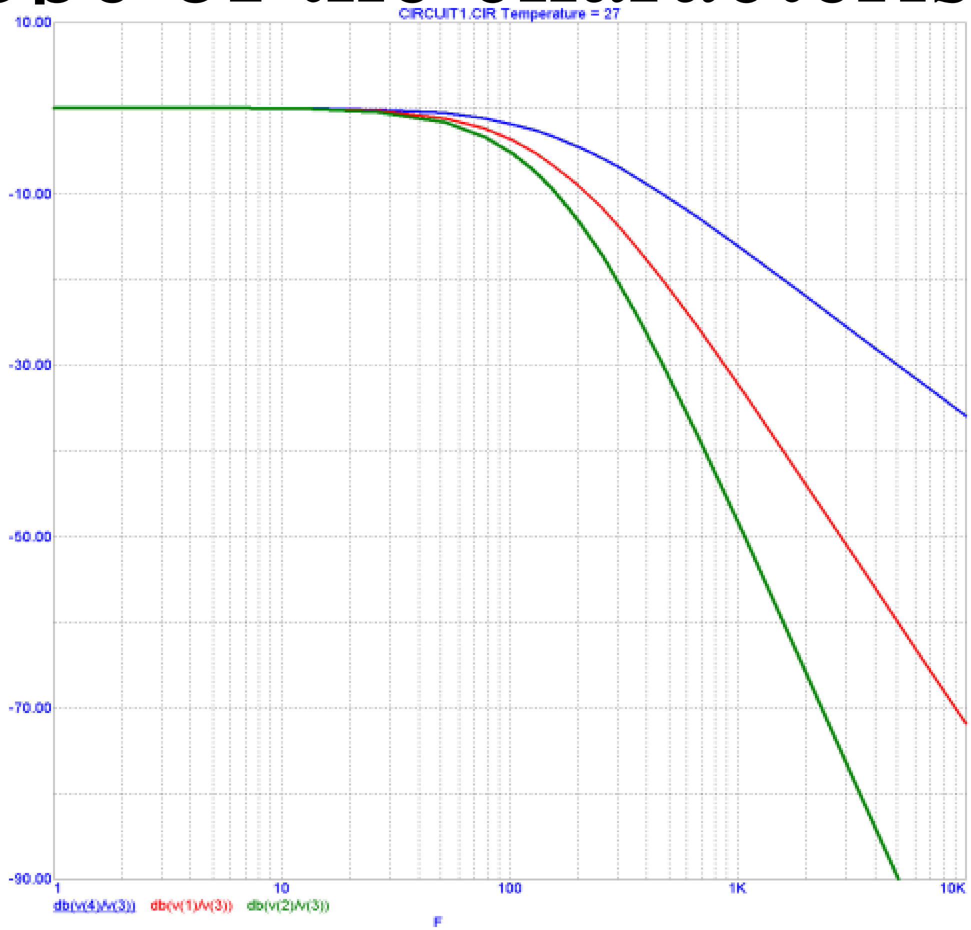
High order filters



Higher order filters are made by cascading a number of sections.

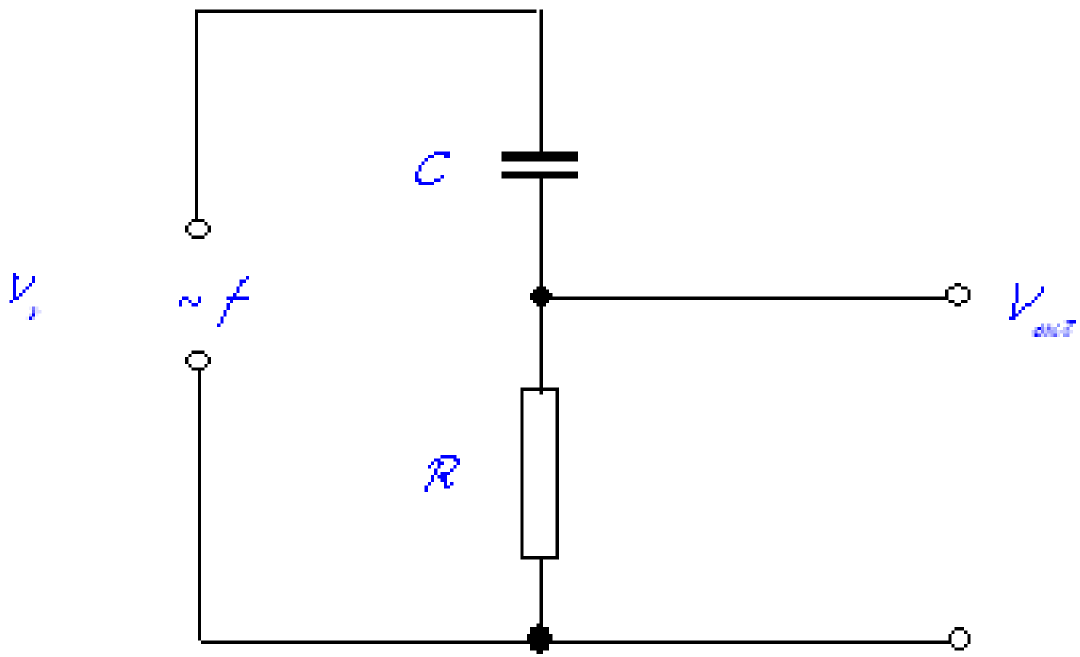
CAUTION! You can not simply cascade identical filters. Each successive section must have much (at least 10 times) higher impedance

Slope of the characteristics



-20dB/dec (-6dB/oct) for single structure (+ for high-pass)

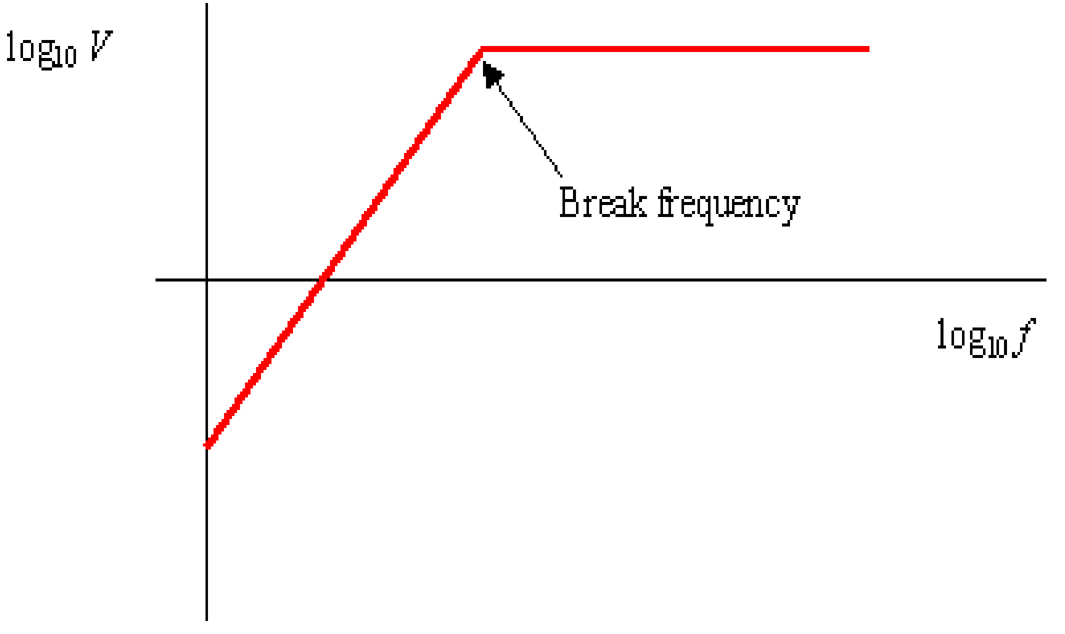
High-pass filter



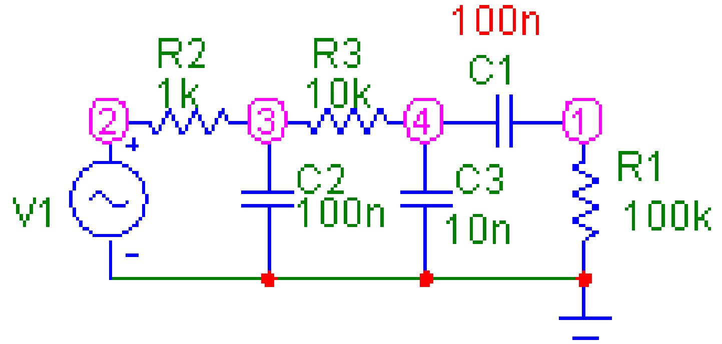
break frequency

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

High-pass filter characteristics

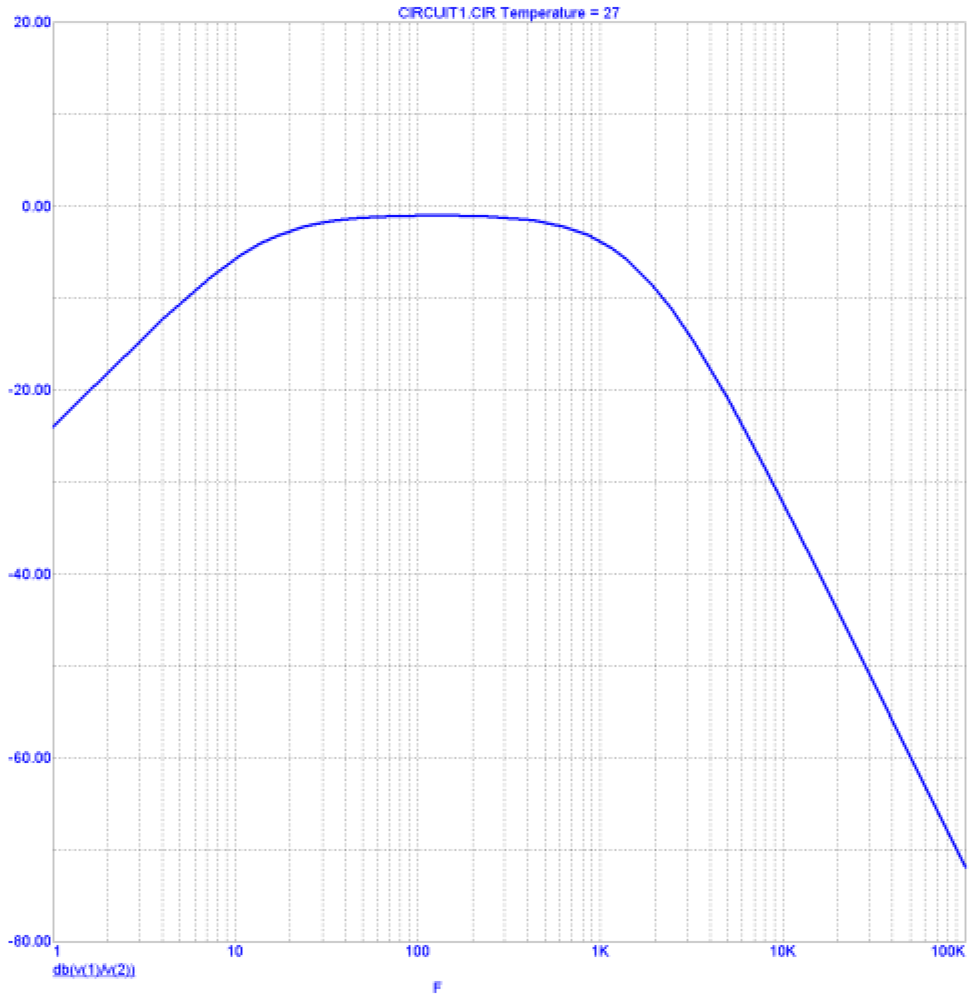


Band-pass filters

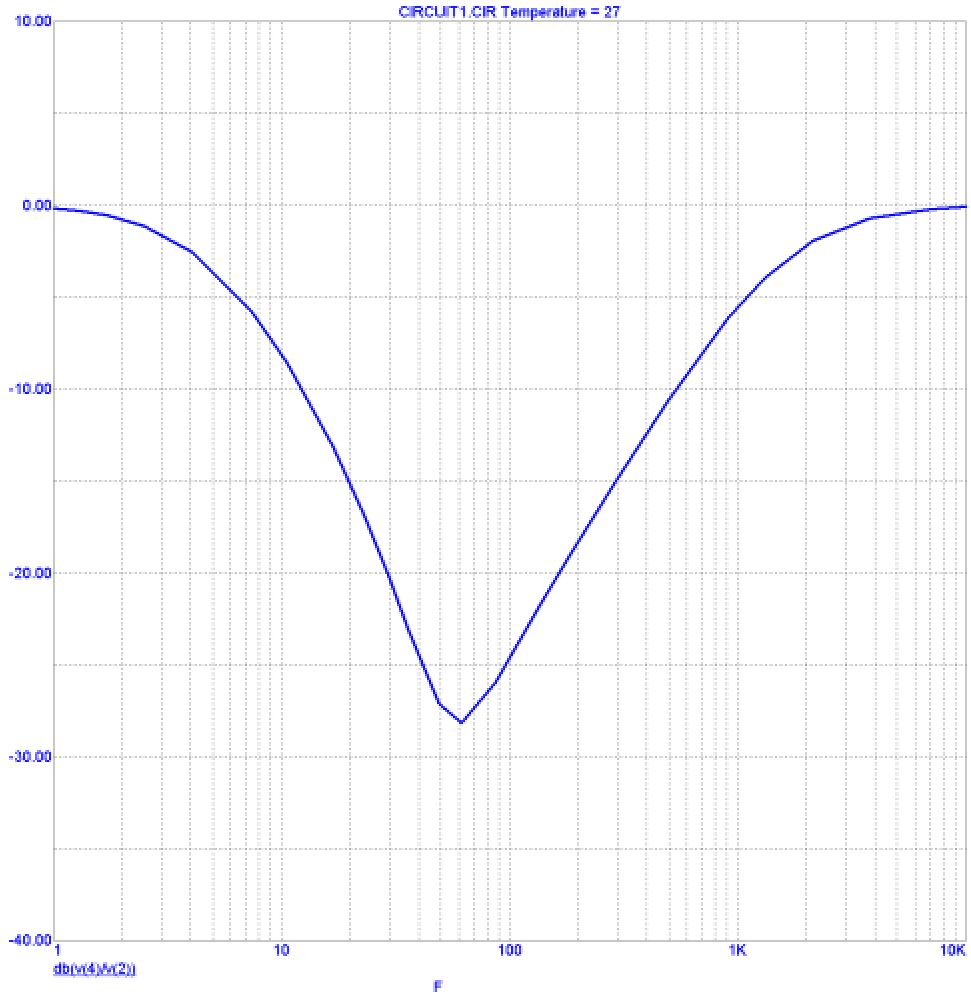


Cascade of both low- and high-pass sections.

Band-pass filter characteristics



How to obtain this?



Band-stop filter (the notch filter)