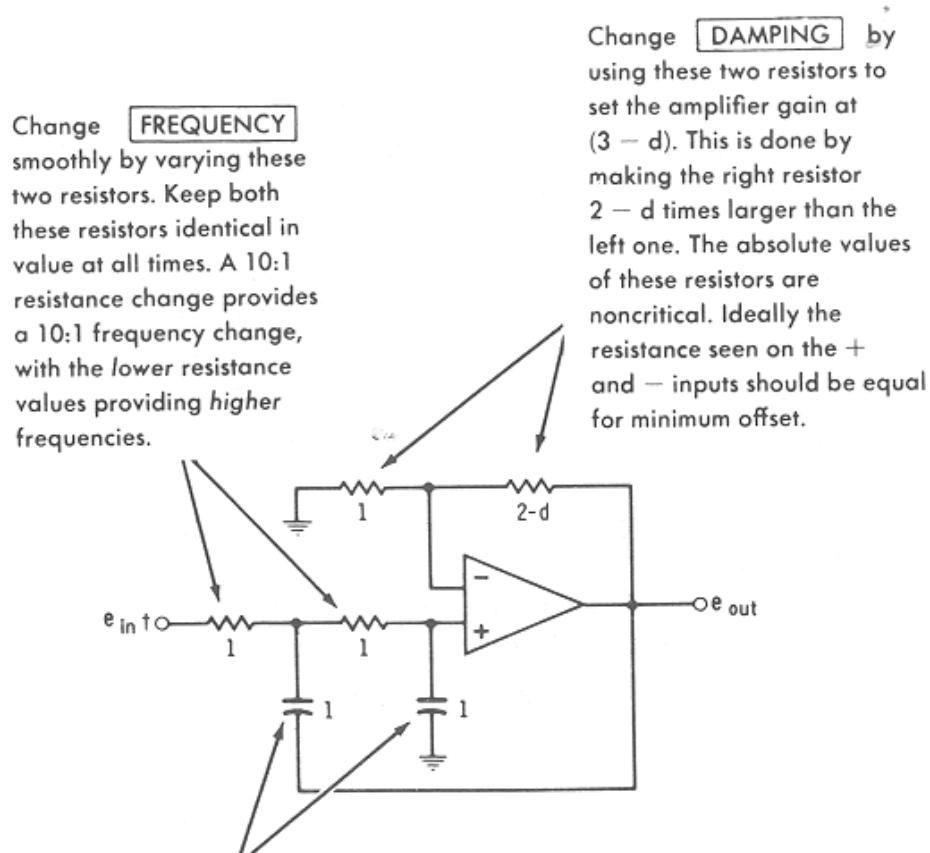# 2nd-Order Sallen-Key Filters

Sallen-Key 2nd-order Low-Pass

Below is a normalized 2nd-order low-pass based on the Sallen-Key (voltage-conbtrolled voltage source, or VCVS) topology.   The element values shown are for a cutoff frequency of 1 rad/sec. Note that the damping factor d in this figures is related to the damping factor discussed in class as $d = 2\xi$.

Change ☐DAMPING☐ by using these two resistors to set the amplifier gain at $(3 - d)$. This is done by making the right resistor $2 - d$ times larger than the left one. The absolute values of these resistors are noncritical. Ideally the resistance seen on the $+$ and $-$ inputs should be equal for minimum offset.

Change ☐FREQUENCY☐ smoothly by varying these two resistors. Keep both these resistors identical in value at all times. A 10:1 resistance change provides a 10:1 frequency change, with the *lower* resistance values providing *higher* frequencies.

Change ☐FREQUENCY☐ in steps by switching these capacitors. Keep both capacitors identical in value at all times. *Doubling* the capacitors *halves* the frequency and vice versa.

† must return to ground via low-impedance dc path.

☐GAIN☐ of this circuit is fixed at $3 - d$ or roughly 2:1 ($+6$ decibels). Adjust signal levels elsewhere in the system.

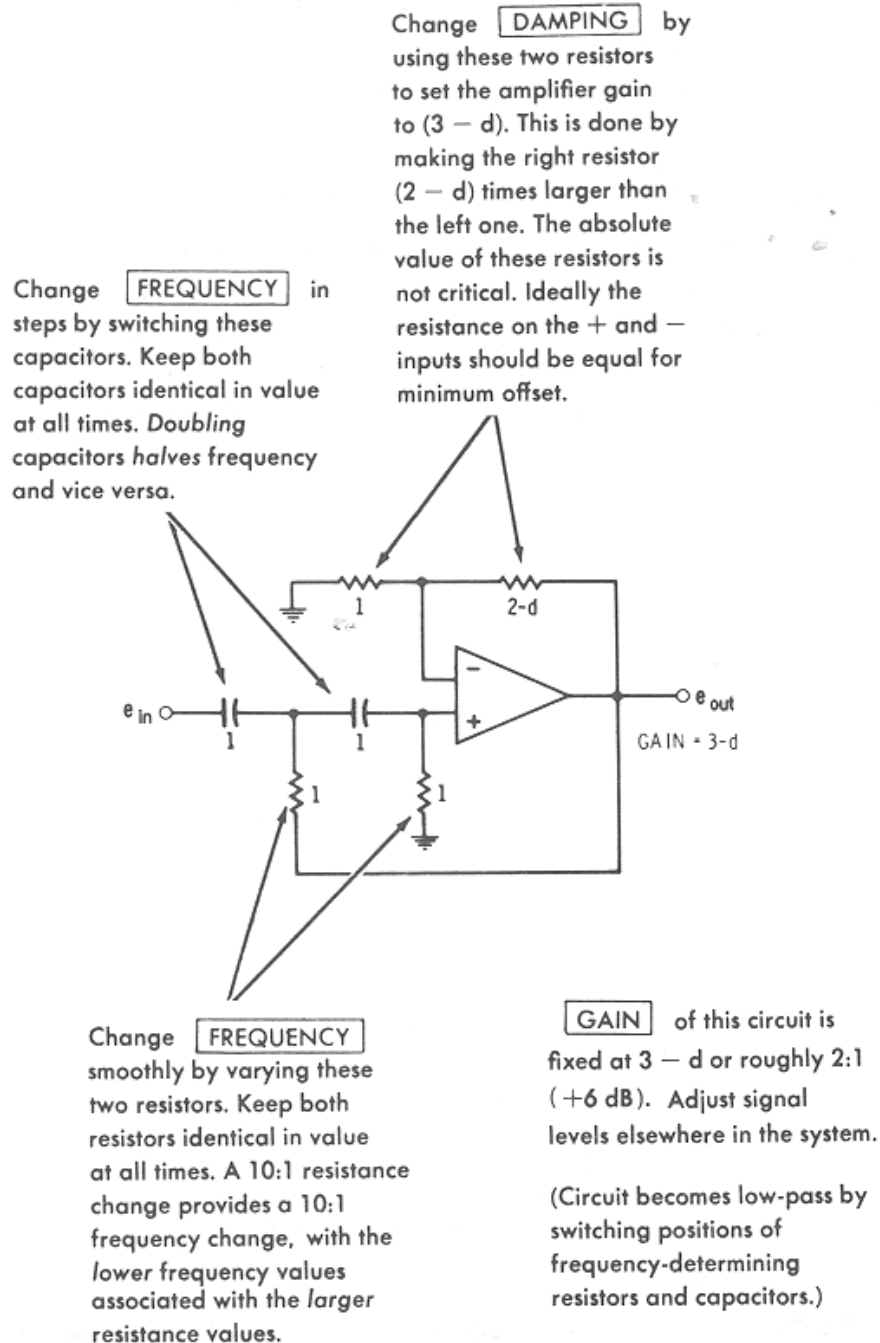(Circuit becomes high-pass by switching positions of frequency-determining resistors and capacitors.)

Sallen-Key equal-component 2nd-order active low-pass (from D. Lancaster, ***Active Filter Cookbook***, Sams Books: New York, 1980).

Sallen-Key 2nd-order High-Pass

Below is a normalized 2nd-order high-pass based on the Sallen-Key topology. The element values shown are for a cutoff frequency of 1 rad/sec. Note that the damping factor d in this figures is related to the damping factor discussed in class as $d = 2\xi$.

Change DAMPING by
using these two resistors
to set the amplifier gain
to (3 − d). This is done by
making the right resistor
(2 − d) times larger than
the left one. The absolute
value of these resistors is
not critical. Ideally the
resistance on the + and −
inputs should be equal for
minimum offset.

Change FREQUENCY in
steps by switching these
capacitors. Keep both
capacitors identical in value
at all times. *Doubling*
capacitors *halves* frequency
and vice versa.

Change FREQUENCY
smoothly by varying these
two resistors. Keep both
resistors identical in value
at all times. A 10:1 resistance
change provides a 10:1
frequency change, with the
lower frequency values
associated with the *larger*
resistance values.

GAIN of this circuit is
fixed at 3 − d or roughly 2:1
(+6 dB). Adjust signal
levels elsewhere in the system.

(Circuit becomes low-pass by
switching positions of
frequency-determining
resistors and capacitors.)

Sallen-Key equal-component 2nd-order active high-pass (from D. Lancaster, ***Active Filter Cookbook***, Sams Books: New York, 1980).