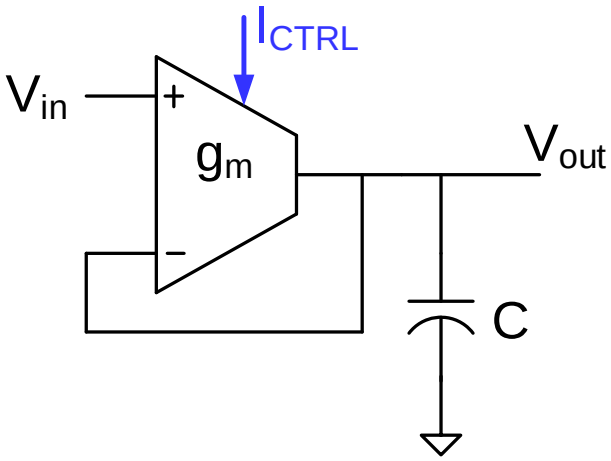
EE 508

Programable Filter Structures

Lab 8 Fall 2024

Programmable Filters

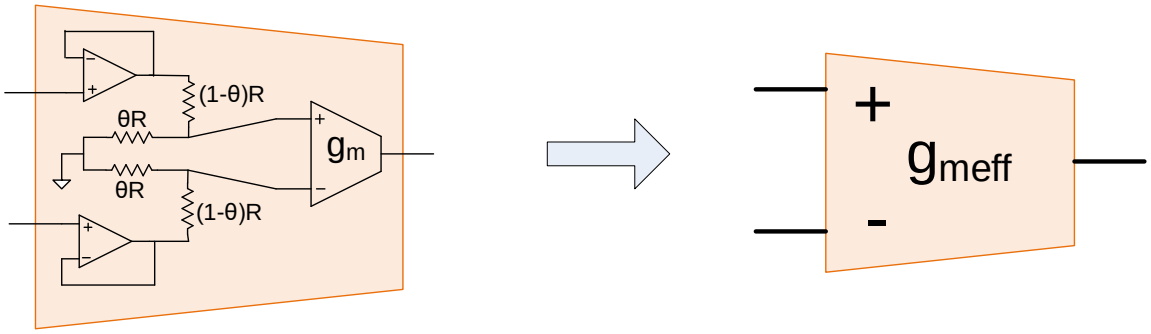
Numerous applications require filters that can be electronically programmed whereby characteristics such as resonant frequency, bandwidth, or even filter type can be adjusted or trimmed with an input current, an input voltage, or a Boolean input signal. Though Boolean control of component values such as resistors or capacitors can be achieved by adding switches to the capacitive components, the area overhead with this approach is often quite large. An alternative is to trim filter characteristics by adjusting the transconductance gain of transconductors in filters where the transfer function is directly dependent upon the transconductance gain. Transconductors whose intended purpose is to provide electronic control of amplifiers and filters are often termed Operational Transconductance Amplifiers. An example showing an OTA-based integrator is shown below where the control current, I_{CTRL}, can be used to program the unity gain frequency of the integrator.



There are a small number of commercially-available discrete OTAs. One of the more popular is the LM 13700 . In this experiment we will work with this device. This device has a transconductance gain that can be adjusted by about six orders of magnitude by programming the bias current.

The maximum input range for the LM 13700 for linear operation is quite small. To increase the effective input range in this experiment we will construct a new OTA by attenuating the input signals as shown in the following figure where the parameter θ should be selected for a

200:1 attenuation. The Op Amp buffers are included at the input to keep the input impedance high. The effective transconductance of this structure is $g_{meff} = \theta g_m$.



Part 1 Design and test a voltage controlled amplifier that has a dc gain that can be varied from 1 to 10 as the dc control voltage is varied between 1V and 2V.

Part 2 Design and test a voltage-controlled 2nd-order bandpass filter that has a constant bandwidth but that has a center frequency that can be varied between 2KHz and 20KHz as a dc control voltage is varied between 1V and 2V.