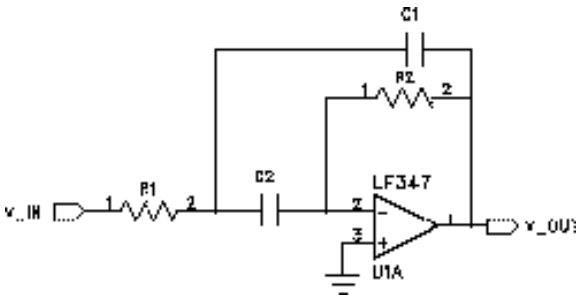

Figure 1: Bandpass filter. $C1 = C2$, $R2 = \frac{2Q}{C\omega_o}$ and $R1 = \frac{R2}{2G}$.

EECS192 Mechatronic Design Laboratory
Operational amplifier notes

1. Ideal Op-amp assumptions
a. v+ approximately equals v- b. input current negligible
c. infinite open loop gain d. zero output impedance
e. infinite slew rate

2. Real World Op-Amp Constraints
a. saturation voltage typically Vsupply - ϵ. Ideal assumptions do not hold in saturation.
b. "There must always be feedback at DC in an op-amp circuit. Otherwise the op-amp is guaranteed to go into saturation". (Horowitz and Hill, 1989)
c. watch out for maximum differential voltage input limit

Rule of thumb: resistor values of 2k to 470k with general purpose op-amps. (Balance between output current limitation and input offset currents).

parameter	LM741 (obsolecent)	LM6144 5 V supply	comments
offset voltage:	6 mV	3.3 mV	
bias current:	500 nA	526 nA	
offset current:	200 nA	80 nA	
slew rate:	0.5V/us max	11 V/uS	75 KHz sinusoid 4 v p-p has 10^6 V/s
unity gain frequency:	1.2 MHz typ	5 MHz typ	
max output current:	20 mA	3 mA min	
max diffl input:	30V	15 V	
Power supply rejection ratio:	76 dB	78 dB	
common mode rejection ratio:	70 dB	64 dB	
input impedance:	2M ohms	126M ohms	

Electrolytic capacitors
(Panasonic HFS series aluminum electrolytic, 47 uF)

Frequency	Ideal Imp.	Actual Impedance
1KHz	3.0	3.0
10KHz	0.3	0.75
100 KHz	0.03	0.6