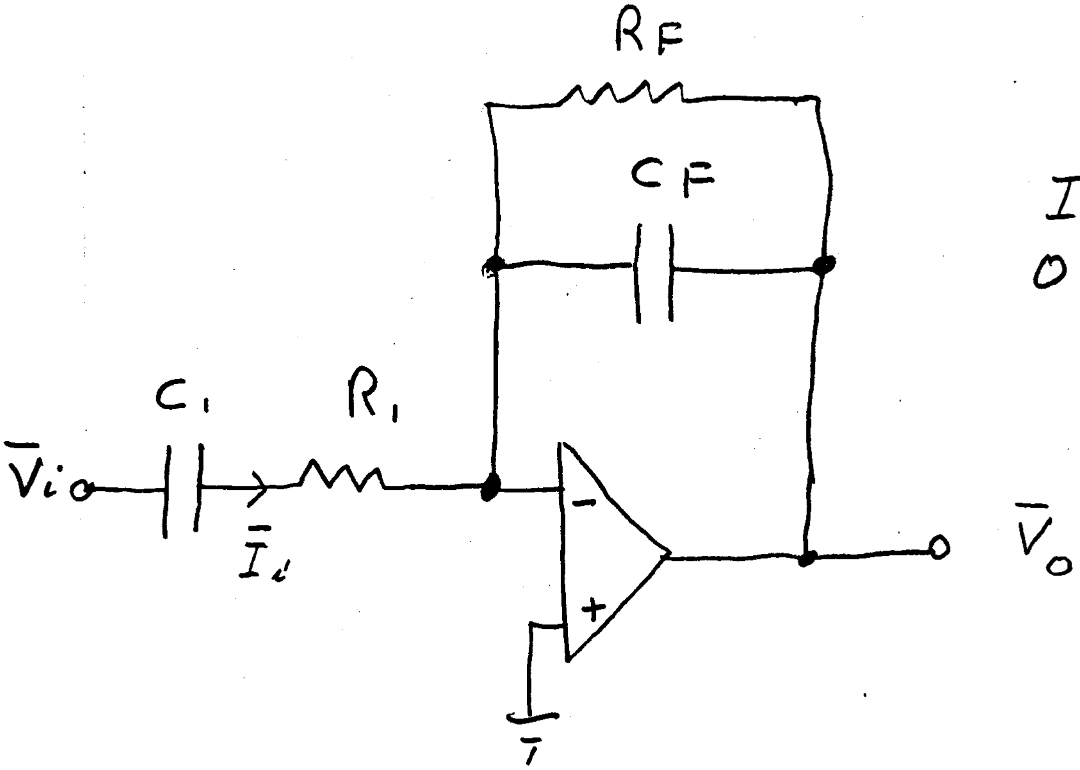
Band Pass Inverting Amplifier



Ideal Op Amp

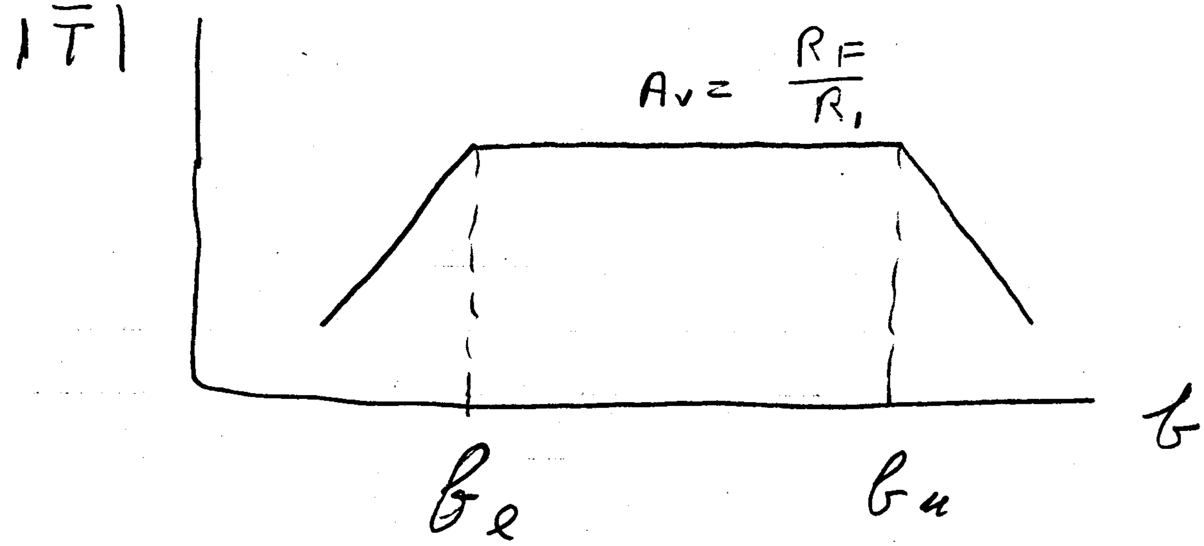
$$\bar{I}_i = \frac{\bar{V}_i}{\bar{Z}_i}, \quad \bar{Z}_i = R_1 + \frac{1}{sC_1} = R_1 \frac{1 + sR_1C_1}{sR_1C_1}$$

$$\bar{V}_o = -\bar{Z}_F \bar{I}_i$$

$$\bar{Z}_F = R_F \,||\, \frac{1}{sC_F} = \frac{R_F}{1 + sR_FC_F}$$

$$\bar{T} = \frac{\bar{V}_o}{\bar{V}_i} = -\frac{R_F}{R_1} \cdot \frac{sR_1C_1}{1 + sR_1C_1} \cdot \frac{1}{1 + sR_FC_F}$$

↑ Constant ↑ HPF ↑ LPF



$$f_l = \frac{1}{2\pi R_1 C_1} \qquad f_u = \frac{1}{2\pi R_F C_F}$$

Assuming component picked so that $f_u >> f_l$

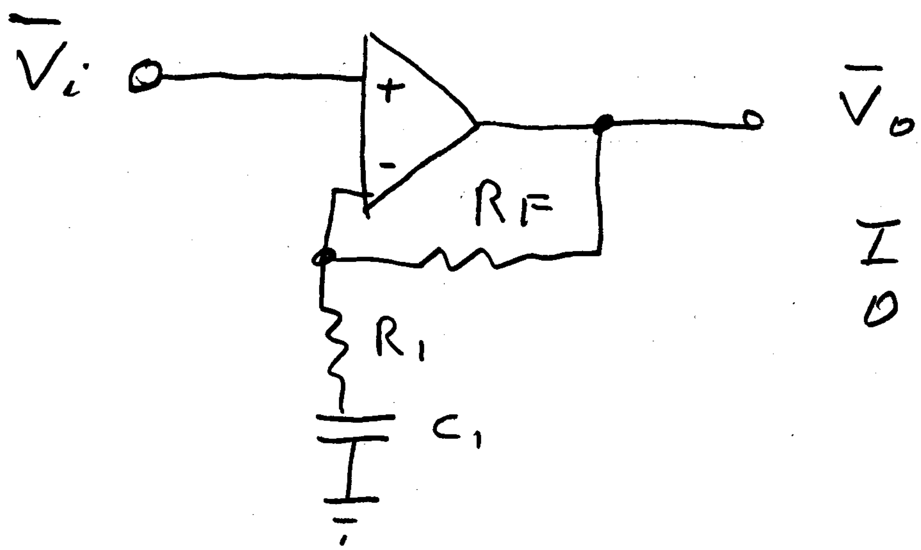
Homework Given $C_1 = 0.1\ \mu F$

A_v f_l f_u

Use Ideal Op Amp

```
.SUBCKT IOA 1 2 3
E 3 0 1 2 1E9
.ENDS IOA
```

Non Inverting Amplifier



Ideal Op Amp

$$\bar{T} = \frac{\bar{V}_o}{\bar{V}_i} = 1 + \frac{\bar{Z}_F}{\bar{Z}_1}, \quad \bar{Z}_1 = R_1 + \frac{1}{sC_1} = R_1\left[\frac{1+sR_1C_1}{sR_1C_1}\right]$$

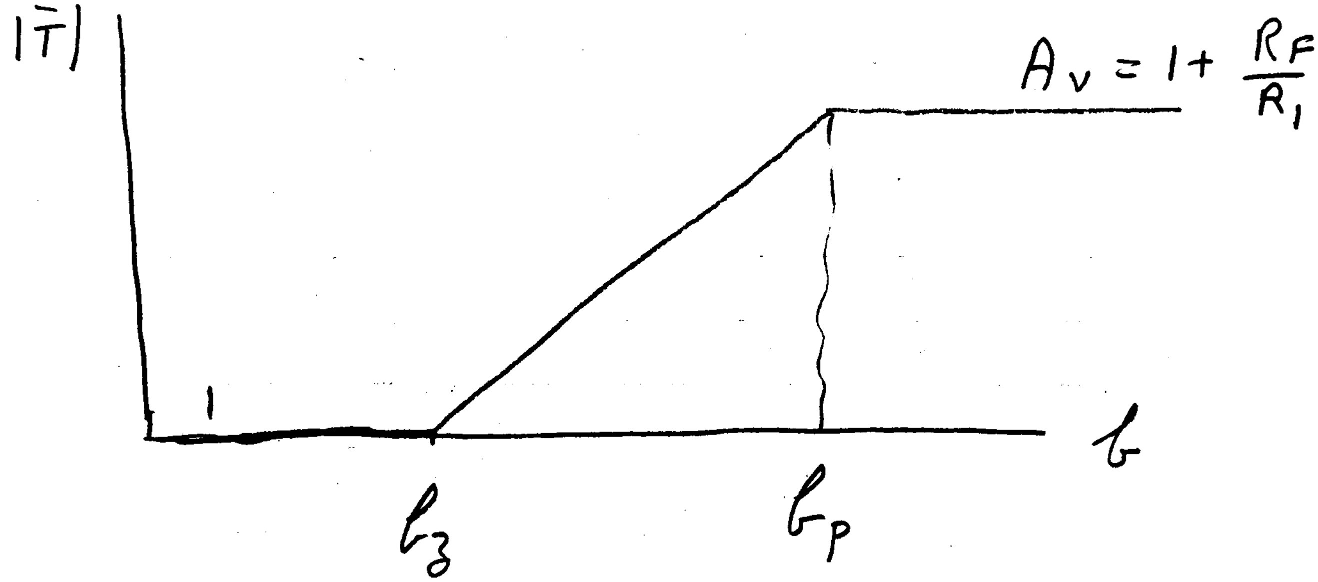
$$\bar{T} = 1 + \frac{R_F}{R_1}\frac{sR_1C_1}{1+sR_1C_1}$$

$$\bar{T} = \frac{1+s(R_1+R_F)C_1}{1+sR_1C_1} = K\frac{1+s\tau_z}{1+s\tau_p}$$

$K = 1$

$$f_z = \frac{1}{2\pi\tau_z} = \frac{1}{2\pi(R_1+R_F)C_1}, \quad f_z < f_p$$

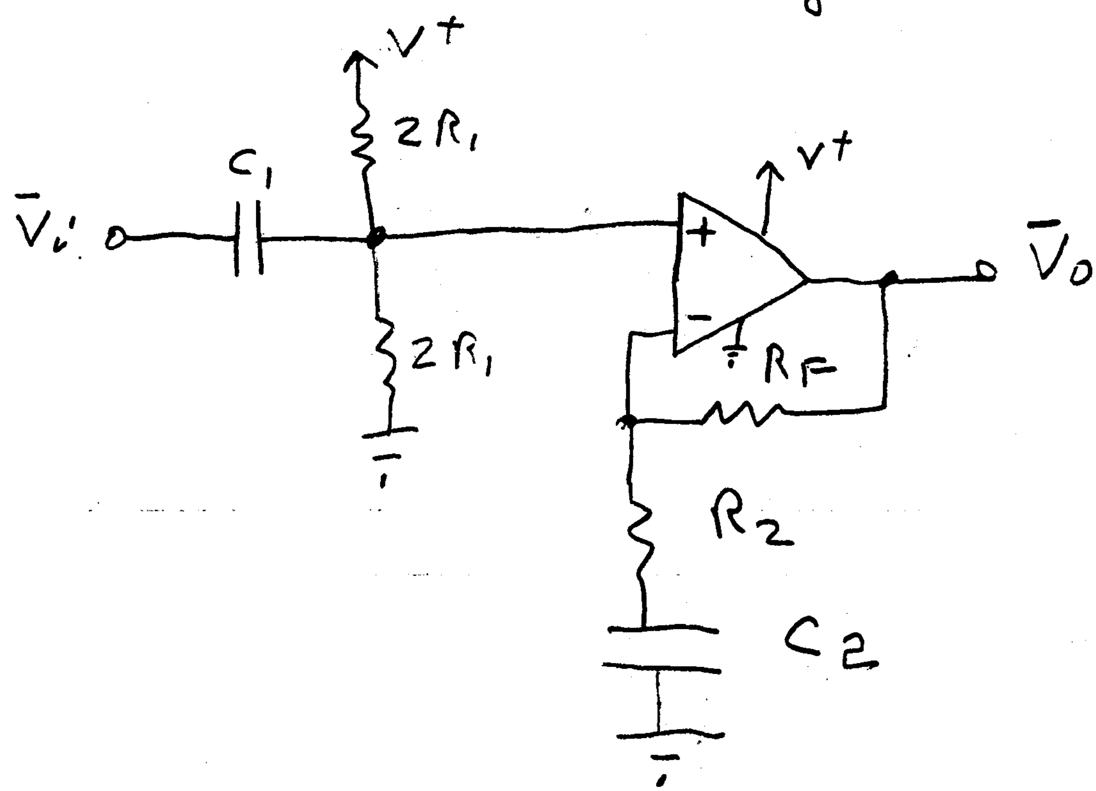
$$f_p = \frac{1}{2\pi\tau_p} = \frac{1}{2\pi R_1 C_1}, \quad \text{HPSF}$$



$A_v \equiv$ midband voltage gain

Single Power Supply Amplifier

Non Inverting



$$\bar{T} = \frac{\bar{V}_o}{\bar{V}_i} = \frac{sR_1C_1}{1+sR_1C_1}\left[1 + \frac{R_F}{R_2 + \frac{1}{sC_2}}\right]$$

$$\bar{T} = \frac{sR_1C_1}{1+sR_1C_1} \quad \frac{1+(R_2+R_F)C_2 s}{1+R_2C_2 s}$$

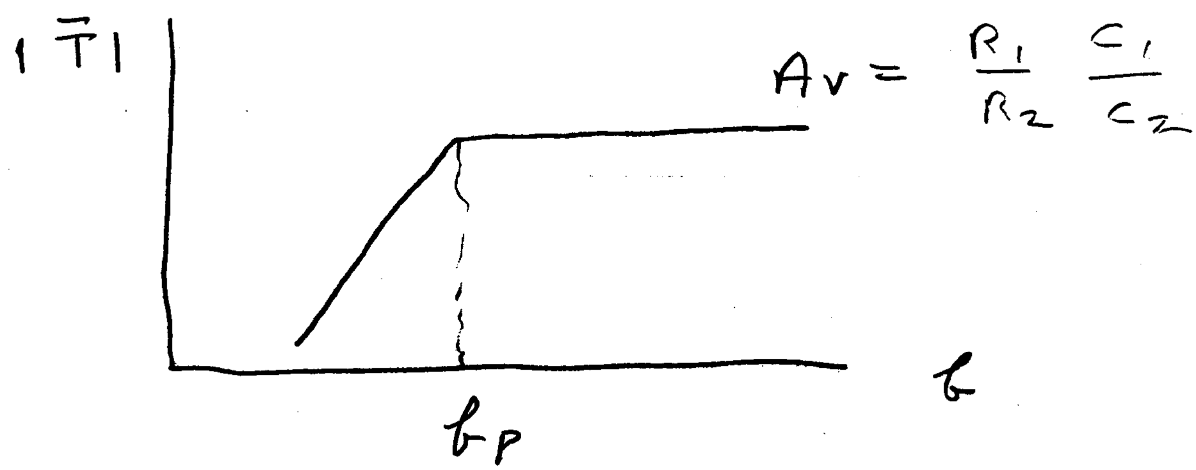
↑ HPF ↑ HPSF

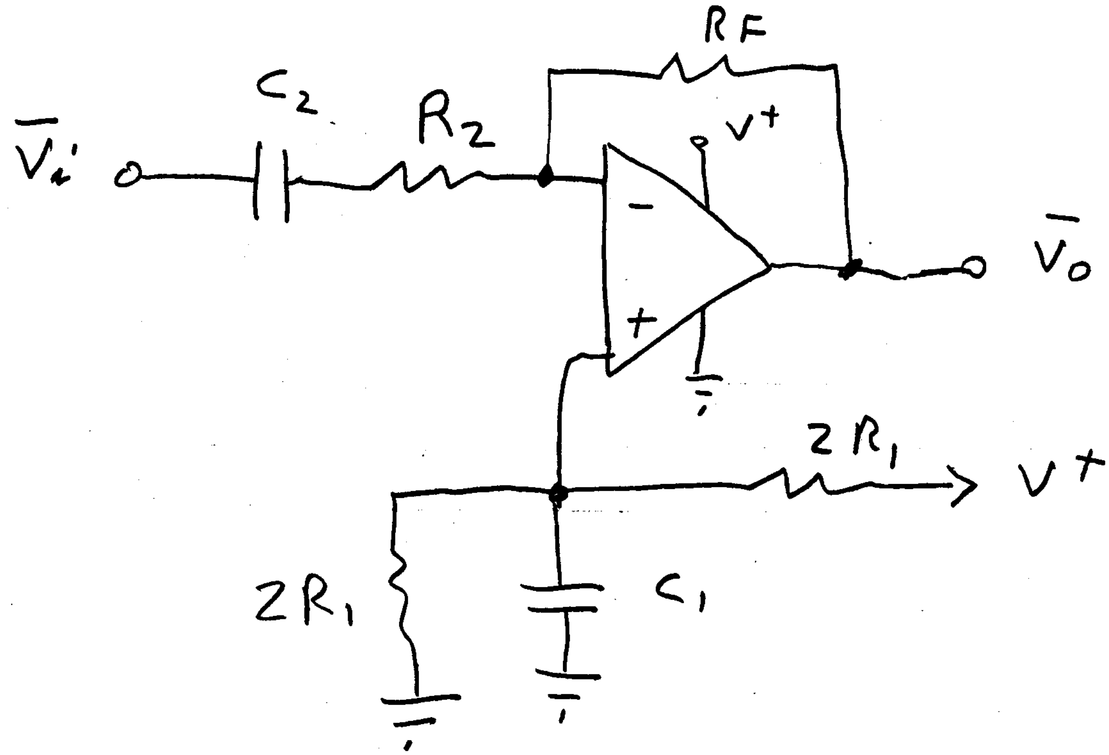
Pick $R_1C_1 = (R_2+R_F)C_2$

$$\bar{T} = \frac{R_1}{R_2}\frac{C_1}{C_2}\frac{sR_2C_2}{1+R_2C_2 s}$$

↑ HPF

pole @ $f_p = \frac{1}{2\pi R_2C_2}$

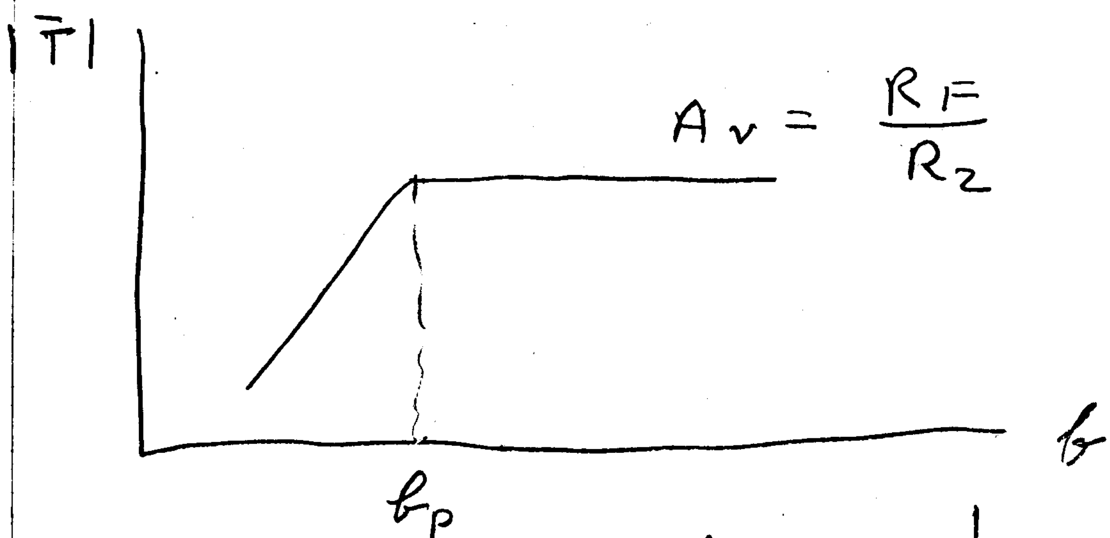




Single Power Supply Inverting

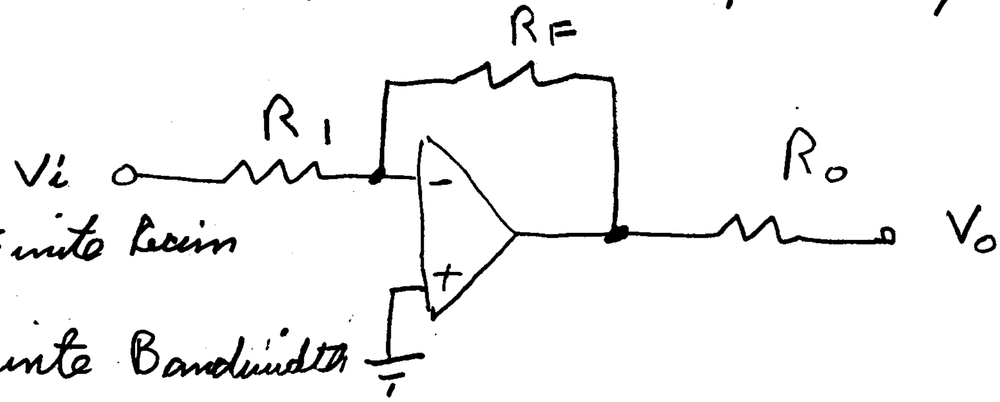
$$\bar{T} = \frac{\bar{V}_o}{\bar{V}_i} = -\frac{R_F}{R_2 + \frac{1}{sC_2}} = -\frac{R_F}{R_2}\,\frac{sR_2C_2}{1+sR_2C_2}$$

↑ HPF



$$f_p = \frac{1}{2\pi R_2 C_2}$$

Non Ideal Op Amp



Finite Gain

Finite Bandwidth

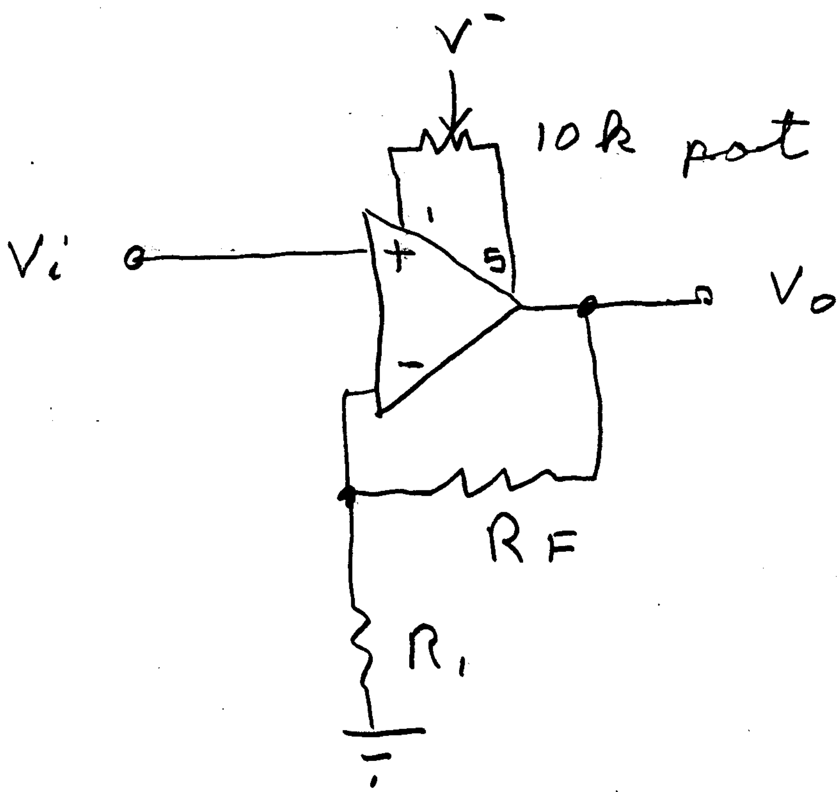
Peak clipping

Output Current Limiting

Slew Rate Limiting

Input Bias Currents (741 High, LF351 Low)

DC Offset



Georgia Institute of Technology

School of Electrical and Computer Engineering

ECE 3042 Microelectronic Circuits Laboratory Verification Sheet

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NAME:____ SECTION:____________________________

GT NUMBER:___________________________________ GTID:_______________________________

Experiment 3: Basic Op-Amp Circuits 2

Procedure	Time Completed	Date Completed	Verification (Must demonstrate circuit)	Points Possible	Points Received
2. Peak Clipping				10	
3. Current Limiting				10	
4. Slewing				10	
5. Dc Offset and Bias Currents				10	
6. Inverting Amplifier				20	
7. Non-Inverting Amplifier				20	
8. Single Power Supply Amplifiers				20	

To be permitted to complete the experiment during the open lab hours, you must complete at least **four** procedures during your scheduled lab period or spend your entire scheduled lab session attempting to do so. A signature below by your lab instructor, Dr. Brewer, or Dr. Robinson permits you to attend the open lab hours to complete the experiment and receive full credit on the report. Without this signature, you may use the open lab to perform the experiment at a 50% penalty.

SIGNATURE:_____________________________________ DATE:______________________________________

ECE 3042 Check-off Requirements for Experiment 3

Make sure you have made all required measurements before requesting a check-off. For all check-offs, you must demonstrate the circuit or measurement to a lab instructor. All screen captures must have a time/date stamp.

2. Peak Clipping
   - ✓ Screen capture displaying 100 Hz input and soft clipping on output. Show measured positive and negative peak output amplitudes (use max and min functions on scope).
   - ✓ Screen capture displaying input and hard clipping on output. Show measured positive and negative output clipping levels (use max and min functions on scope).
3. Current Limiting
   - ✓ Screen capture displaying 100 Hz input and soft clipping (verge of current limiting) on output. Show measured positive and negative peak output amplitudes (use max and min functions on scope).
   - ✓ Screen capture displaying input and hard clipping (hard current limiting) on output. Show measured positive and negative output clipping levels (use max and min functions on scope).
   - ✓ Calculation of positive and negative peak currents for both verge of current limiting and hard current limiting.
4. Slewing
   - ✓ Screen capture displaying input SQUARE wave and slewed output. Show two cursors used to measure the positive slope.
   - ✓ Screen capture displaying input SQUARE wave and slewed output. Show two cursors used to measure the negative slope.
   - ✓ Calculation of the positive and negative slew rates from the Δx and Δy data from the cursor measurements. Express the results in V/μs.
5. DC Offset and Bias Currents
   - ✓ Screen capture showing input and output and measured Vpp for each before pot is added to circuit. Make sure both channels of the scope are dc coupled.
   - ✓ Measurement of dc voltages at the output of each op-amp with dmm before adding pot to circuit.
   - ✓ Screen capture showing input and output and measured Vpp for each after pot is added to circuit and adjusted to minimize the dc offset at the output. Make sure both channels of the scope are dc coupled.
   - ✓ Measurement of dc voltages at the output of each op-amp with dmm after adding pot to circuit and adjusting the pot to minimize the dc voltage at the output of the second op-amp.
6. Inverting Amplifier
   - ✓ Plot of gain versus frequency using HPVEE or LabView. Use a frequency range of 10 Hz to 100 kHz and an input voltage of 0.1 Vrms.
   - ✓ Recorded midband gain, upper cutoff frequency, and lower cutoff frequency. Use cursors to measure.
7. Non-Inverting Amplifier
   - ✓ Same as for 6, but only measure the pass-band gain and the pole frequency.
8. Single power Supply Amplifiers
   - ✓ Same as for 7 for each of the two amplifiers.