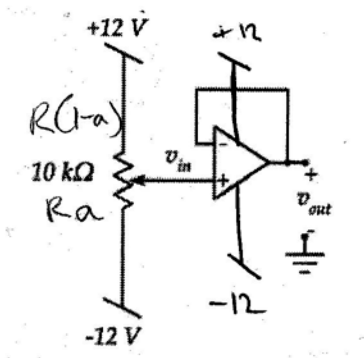
Ruby Spring

Lab 2

In this lab we used an Op-Amp for three circuits: a voltage buffer, a Schmitt trigger, and an inverted amplifier. We then graphed data for V_{in} vs. V_{out} from each circuit using a matlab program that pulls the data from a scope.

1. Buffer



This circuit provides variable input V_{in} and produces V_{out} equal to V_{in}

to find v_{out}:

$V_{in} = V_s - \Delta V$

$\Delta V = I*R(1 - a)$

$I = 2V_s/R$

$\Delta V = (2V_s/R)*R(1 - a)$

therefore $V_{in} = V_s - 2V_s*(1 - a)$

but $V_{in} = V_{out}$

Therefore $V_{out} = V_s - 2V_s*(1 - a)$

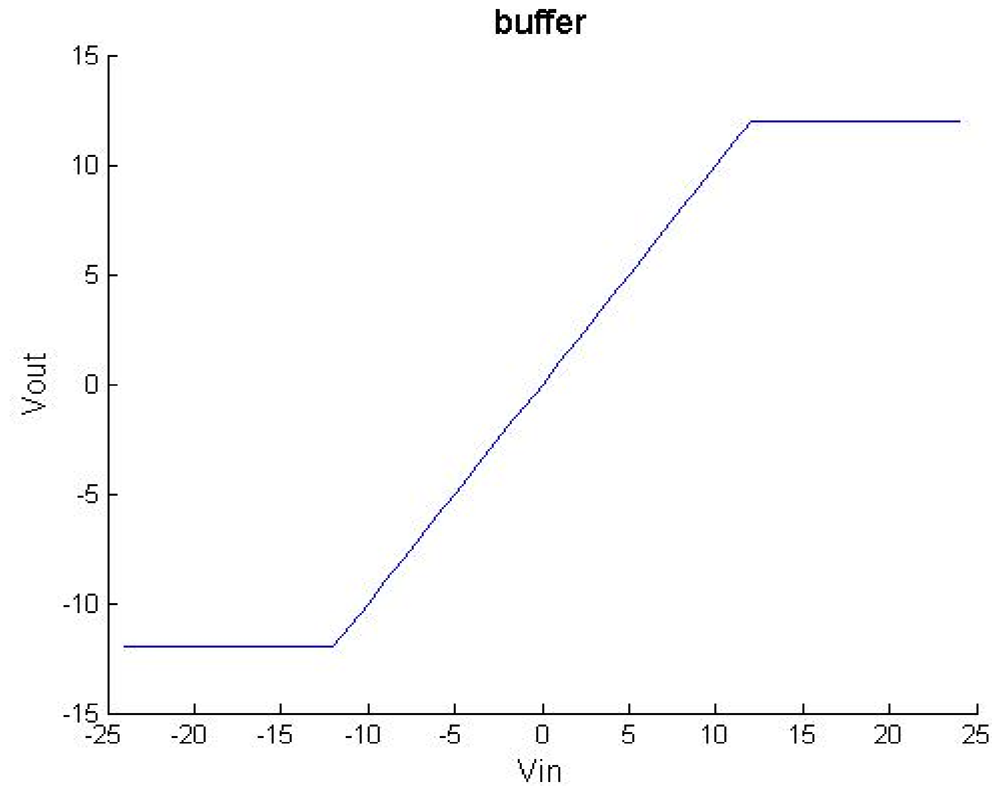
This is true for region I of the graph of V_{in} vs. V_{out}

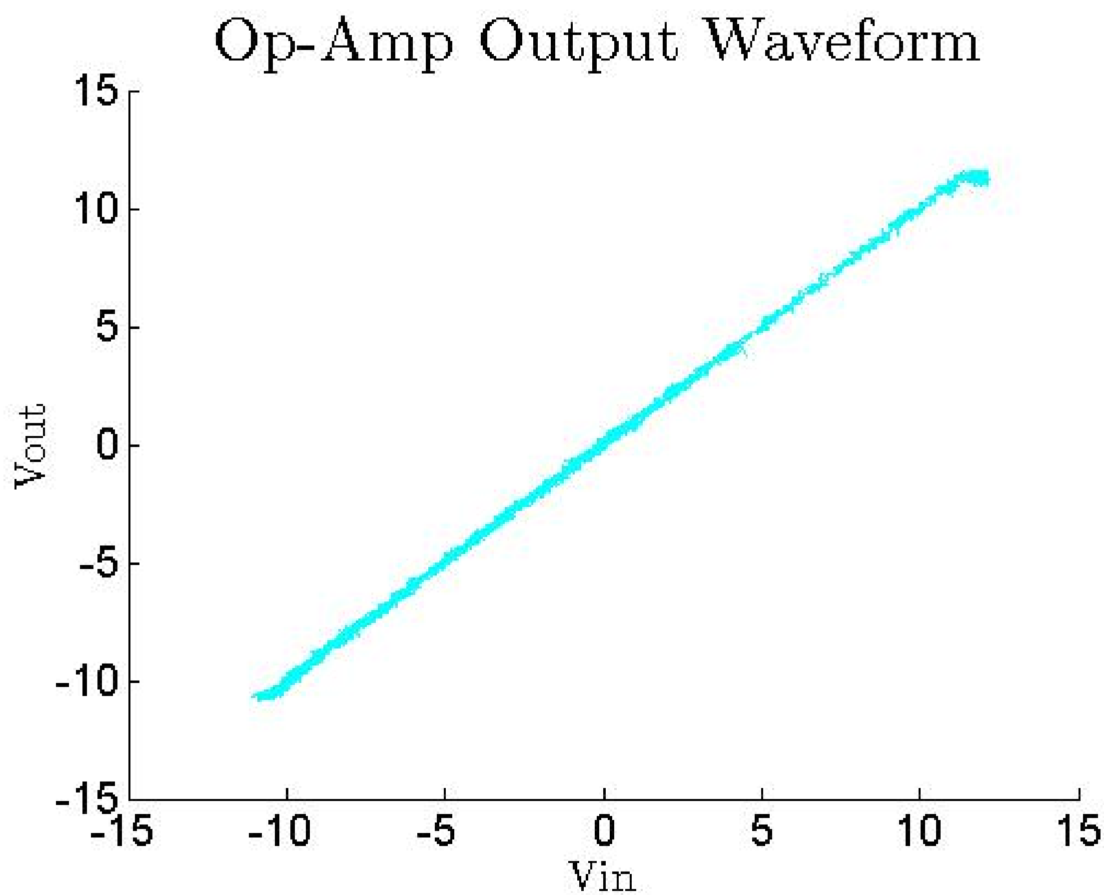
I. $V_{out} = V_{in}$ when $-V_s<V_{out}<V_s$

II. $V_{out} = V_s$ when $V_{in}>V_s$

III. $V_{out} = -V_s$ when $V_{in}<V_s$

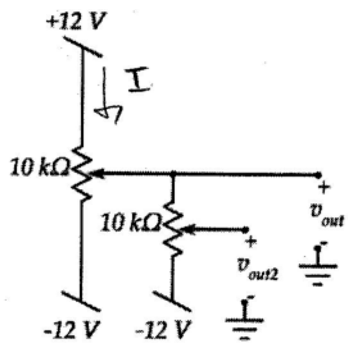
Below is the theoretical graph followed by experimental data from the buffer.


buffer
15
10
5
0
-5
-10
-15
Vout
-25
-20
-15
-10
-5
0
5
10
15
20
25
Vin


Op-Amp Output Waveform
15
10
5
0
-5
-10
-15
Vout
-15
-10
-5
0
5
10
15
Vin

2. Comparing two circuits

circuit 1:



$V_{out} = V_s - \Delta V$

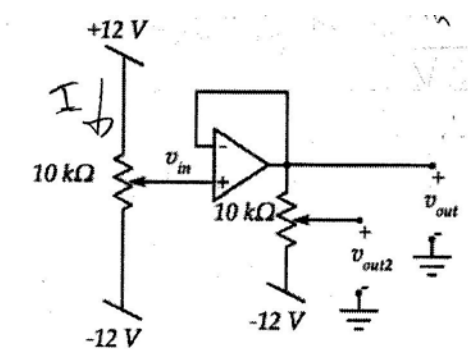
$\Delta V = I*R_{acrossVout} = (2V_s/R_{eq})*(R/2)$

$R_{eq} = .5R*R/(.5R + R) + R = 5R/6$

$V_{out} = V_s - (2V_s/(5R/6))*(R/2) = V_s - 12V_s/10$

$V_{out} = -2.4V$

circuit 2 :



$V_{in} = V_{out}$

$V_{in} = V_s - \Delta V = V_s - (2V_s/R)*(R/2) = V_s - V_s = 0$

$V_{out} = 0$

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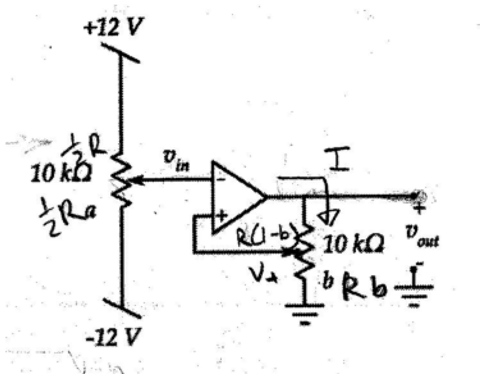
3. Schmitt Trigger



we know that for region I $V_{in} = V_- = V_+$ but what is V_{out} in terms of V_{in}?

since $V_{in} = V_+$ and V_+ intersects with V_{out}, it will be helpful to find V_+

$V_+ = V_{out} - I*R(1-b)$

$I = V_{out}/R$

therefore $V_+ = V_{out} - (V_{out}/R)*R(1-b)$

which simplifies to $V_+ = b*V_{out}$

but we also know that $V_{in} = V_+$

therefore $V_{in} = b*V_{out}$ and we can see that our slope for region I will be 1/b

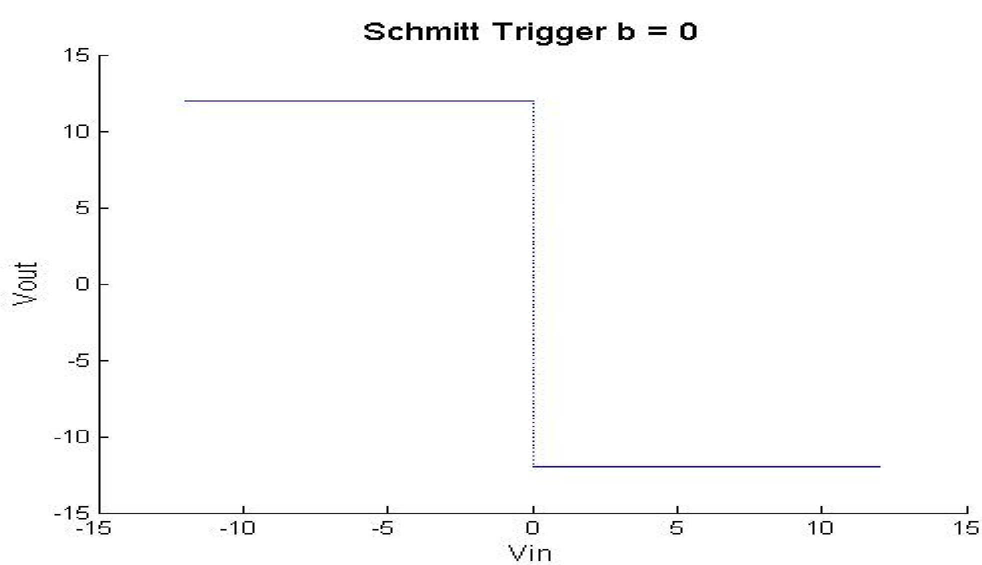
yay! know we know what our regions will look like:

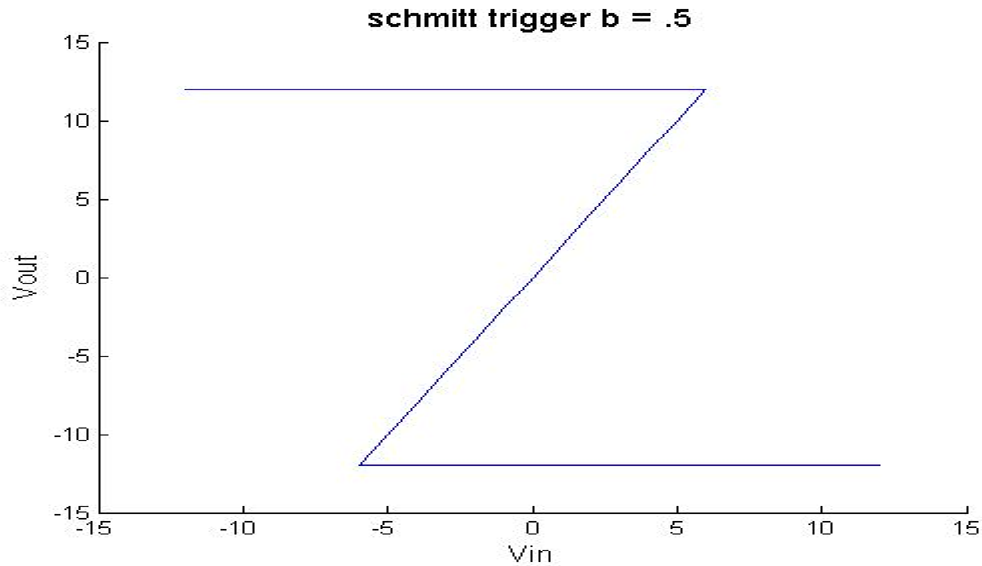
I. $V_{in} = V_- = V_+$ and $V_{in} = b*V_{out}$

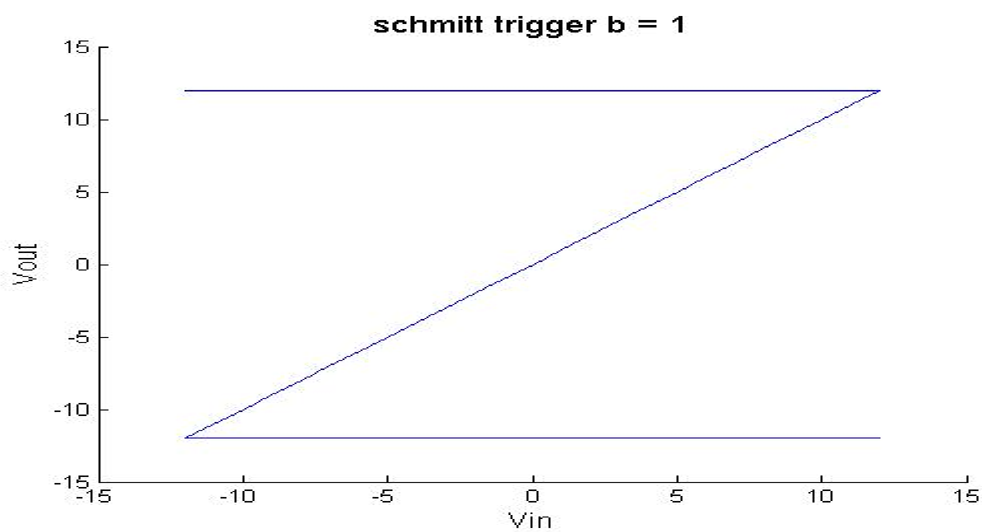
II. $V_{in} < b*V_{out}$ and $V_{out} = V_s$

III. $V_{in} > b*V_{out}$ and $V_{out} = -V_s$

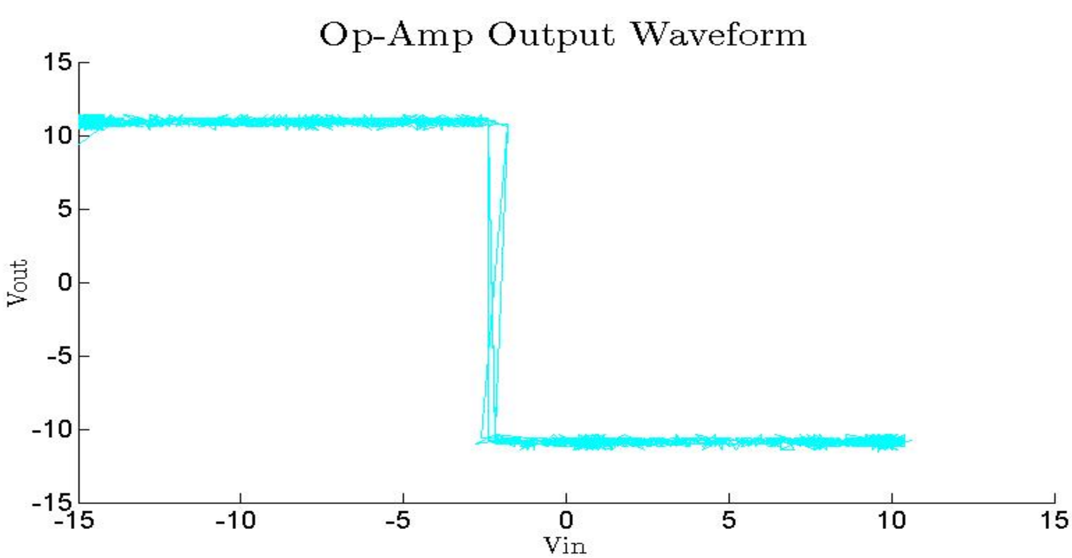
here are the theoretical graphs for three values of potentiometer b:

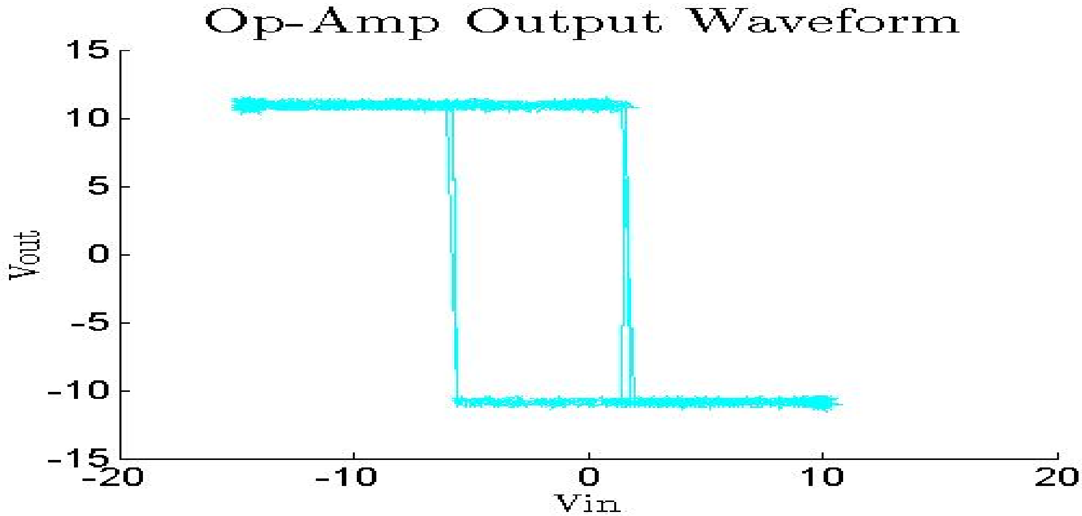


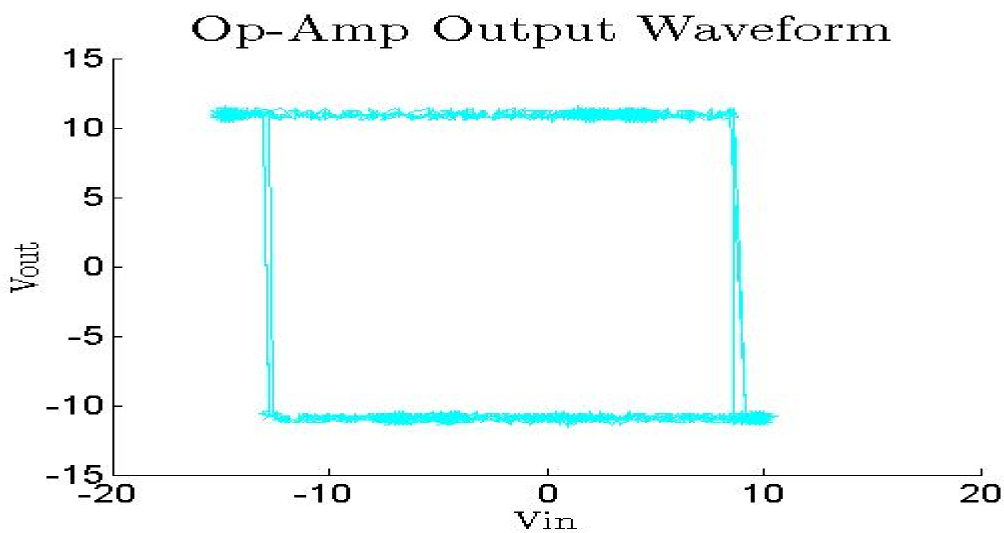




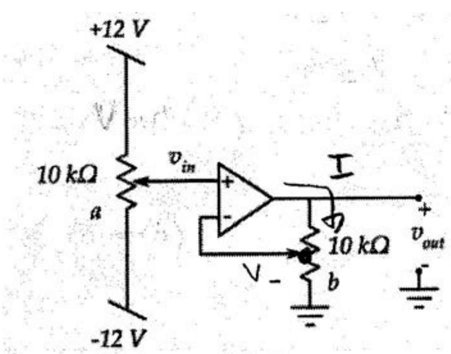
here is the experimental data for three values of pot b! Any weird noise is probably a result of bad Op-Amp function.







4. non-inverting trigger



This circuit is the same as a shmitt trigger but with positive feedback instead of negative (aka positive and negative are swapped).

so all we have to do for region I is replace V_+ with V_- !

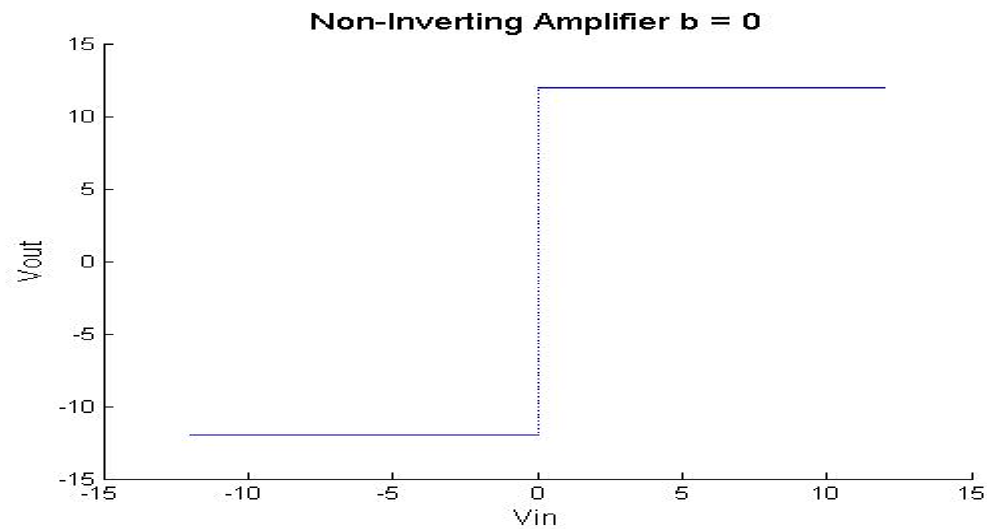
therefore $V_{in} = V_- = b*V_{out}$ and for the three regions we have

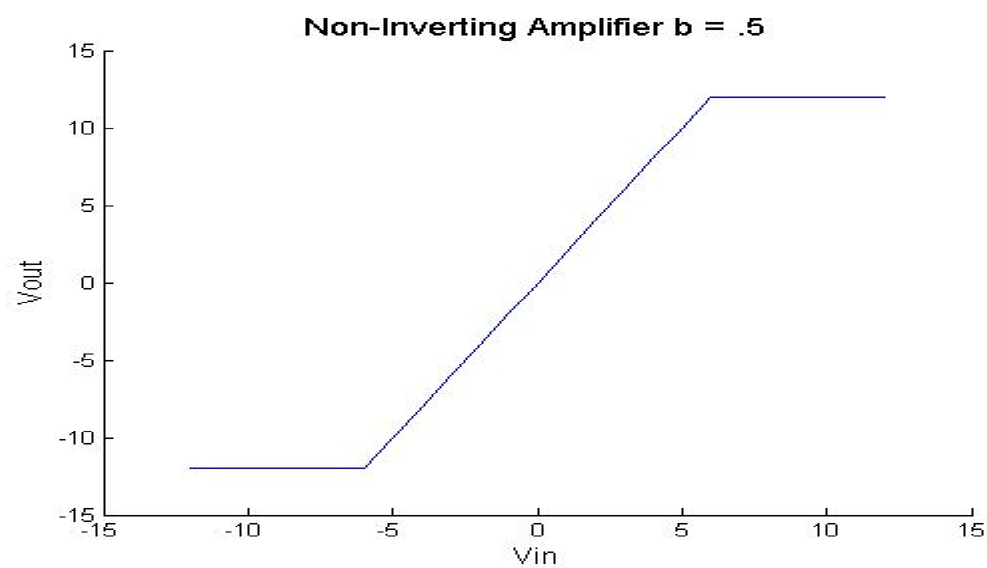
I. $V_{in} = V_- = V_+$ and $V_{in} = b*V_{out}$

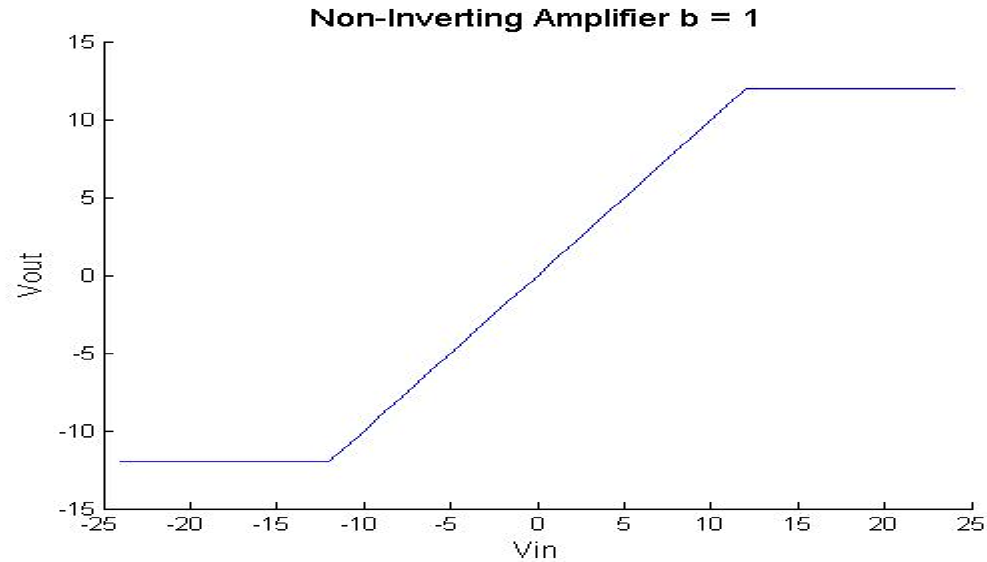
II. $V_{in} > b*V_{out}$ and $V_{out} = V_s$

III. $V_{in} < b*V_{out}$ and $V_{out} = -V_s$

here are the theoretical graphs for three values of potentiometer b:







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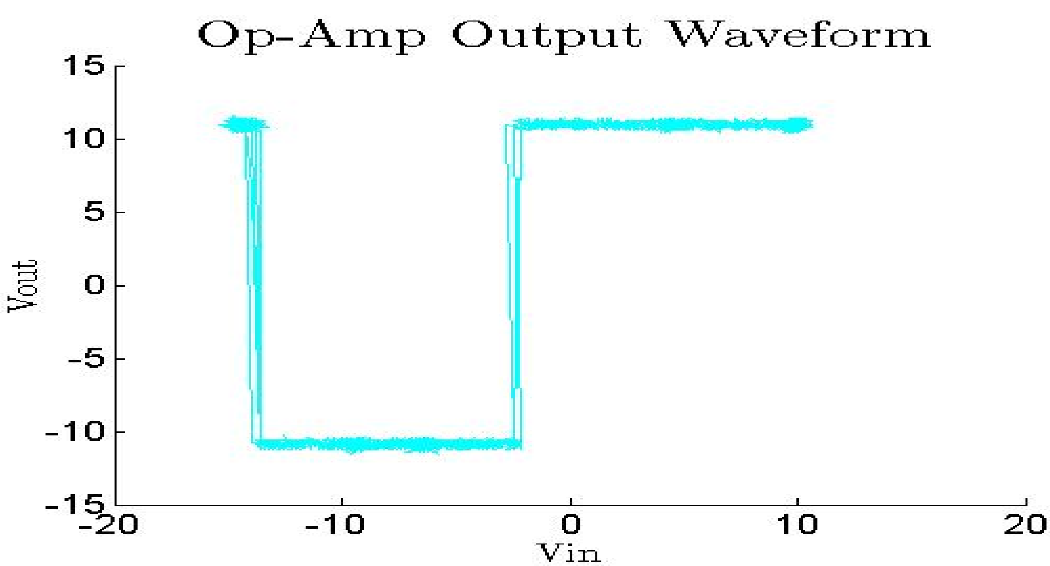

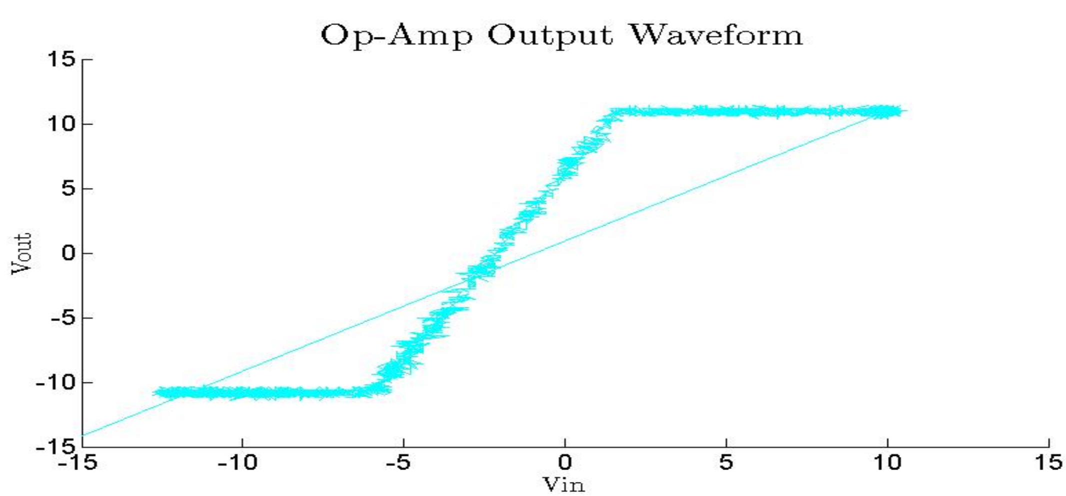

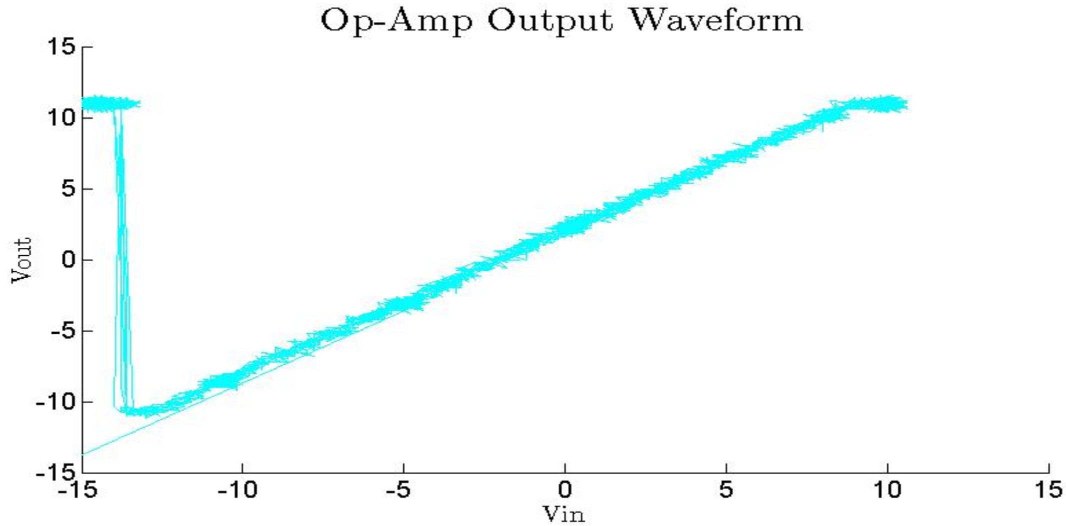
Op-Amp Output Waveform
Vout
Vin
15
10
5
0
-5
-10
-15
-15
-10
-5
0
5
10
15