Electronics Design Principles

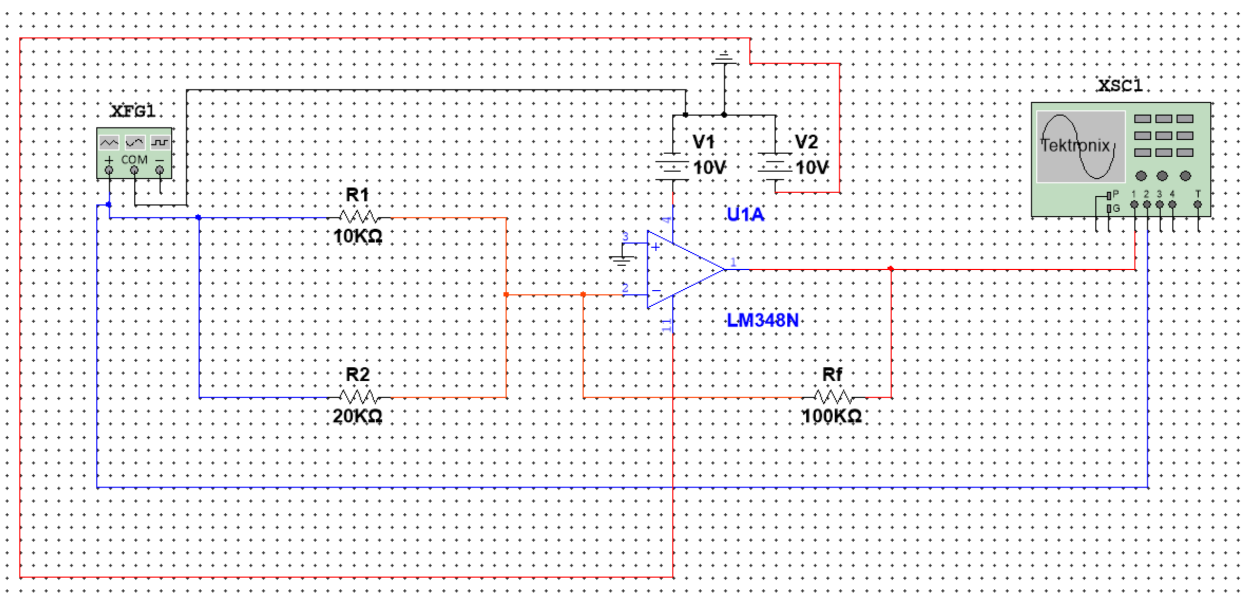
Scaled Adder

Name: Rajkaran Singh Grewal
Student No: 8882386
Student Email: rgrewal2386@conestogac.on.ca

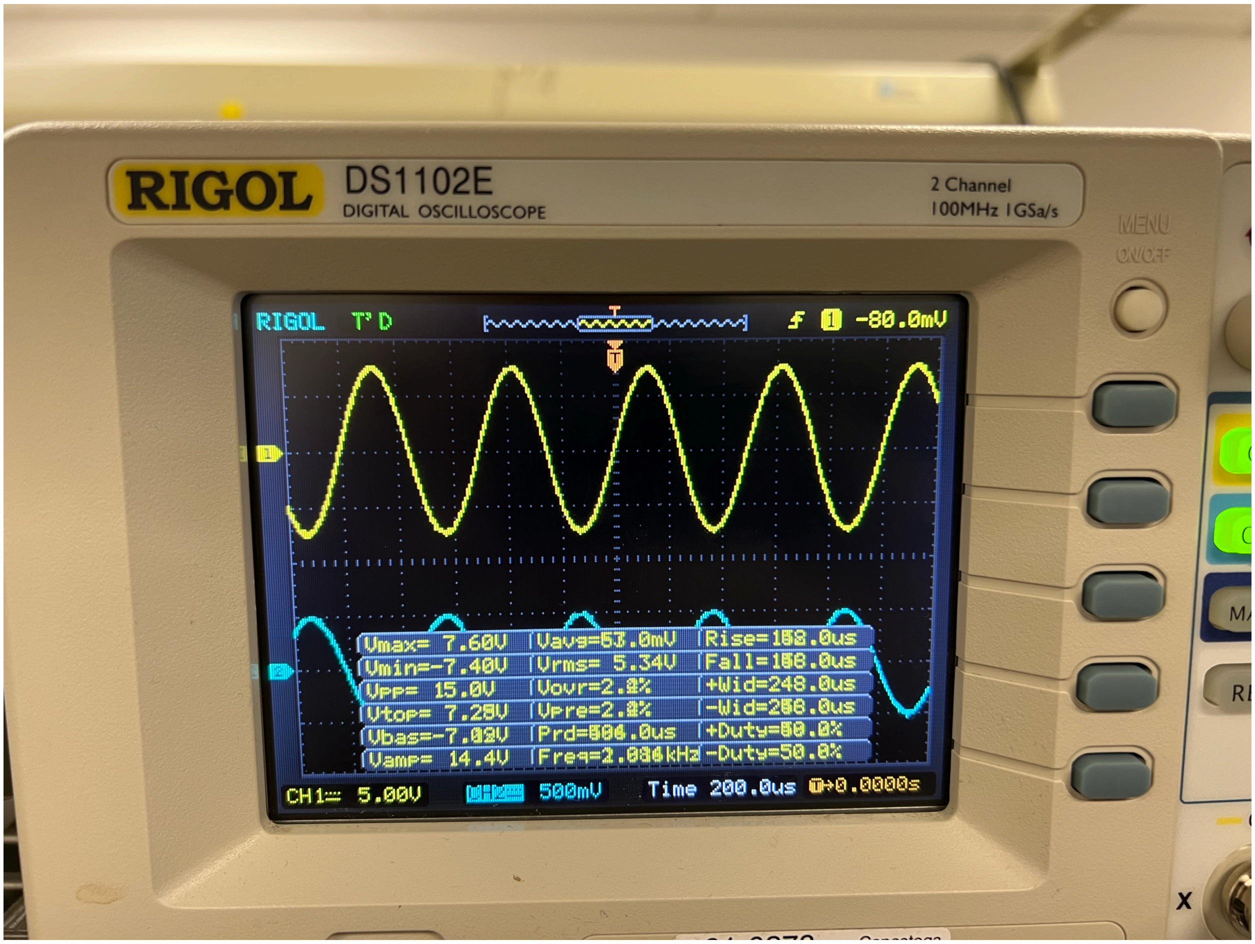
Object: Build a scaled adder that is inverting input R1 will be amplified by 10 and the other R2 by 5.
Use 10 Kohm resister for the input resistor R1 and calculate Rf. Use the same Rf to calculate R2.
Show your design in using MultiSim in your pre-lab.
Prepare a table for measurement in advance to prove that your circuit work by comparing your calculated values with the actual values.

Equipment: Oscilloscope, power supply, function generator, resistors, LM348M op amp, wires, breadboard.

Schematic:



Output:
Case 1: Vpp = 1.0V



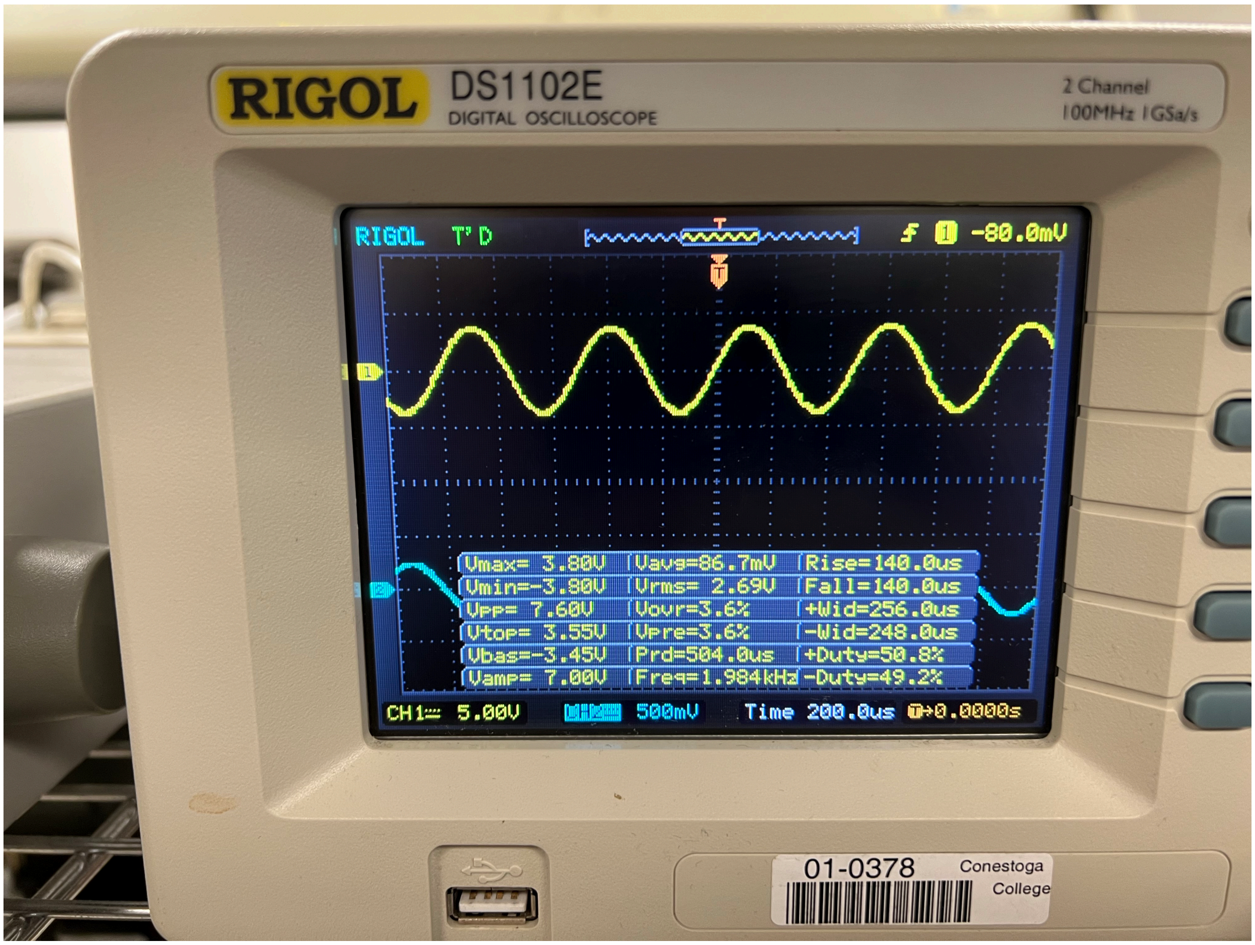
Real Values

Type	CH1	CH2
V_{max}	7.6V	500mV
V_{min}	—7.4V	-500mV
V_{pp}	15V	1V
V_{top}	7.25V	463mV
V_{base}	-7.02V	-477mV
Period	500.0us	500.0us
Frequency	2kHz	2.016kHz

Multisim Value

Type	CH1	CH2
Pk-Pk	14.9V	999mV
Min	-7.49V	-499mV
Max	7.5V	499V

Case 2: Vpp = 500mV



Real Value

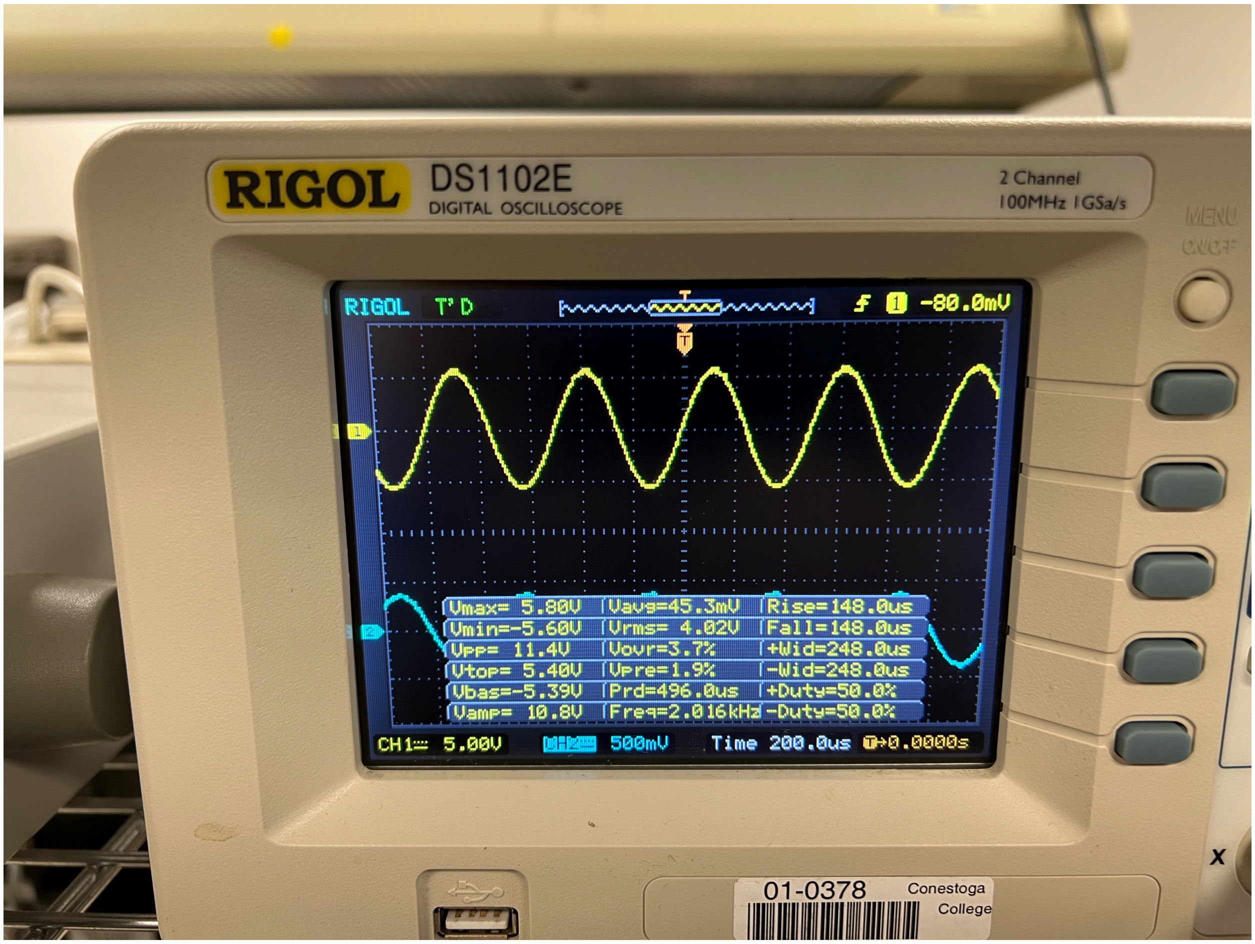
Type	CH1	CH2
V_{max}	3.8V	240mV
V_{min}	-3.8V	-260mV
V_{pp}	7.6V	500mV
V_{top}	3.55V	216mV

Type	CH1	CH2
V_{base}	-3.45V	-235mV
Period	500.0us	500.0us
Frequency	2kHz	2kHz

Multisim Value

Type	CH1	CH2
Pk-Pk	7.47V	499mV
Min	-3.73V	-249V
Max	3.74V	249V

Case 3: Vpp = 750mV



Real Value

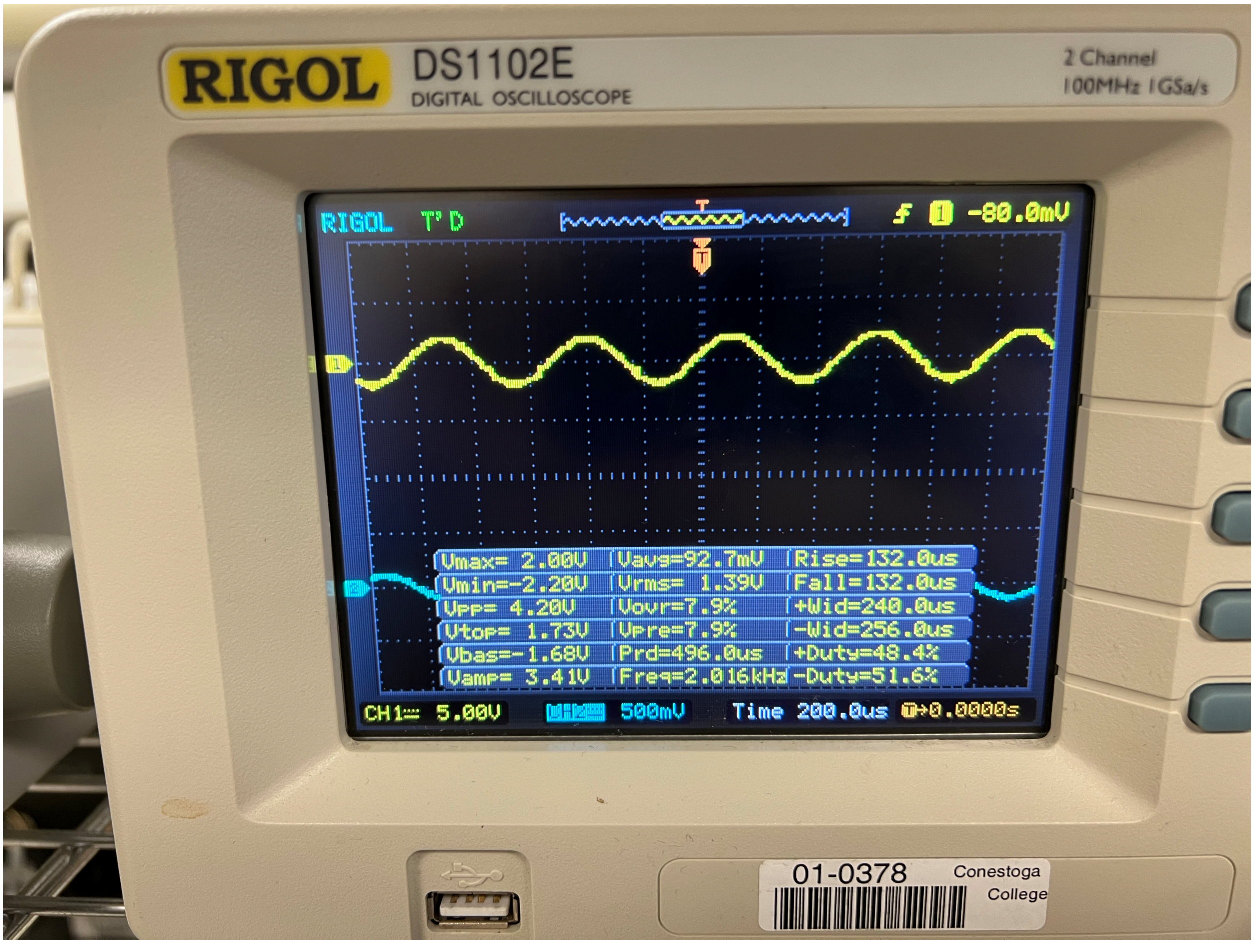
Type	CH1	CH2
V_{max}	5.8V	380mV
V_{min}	-5.6V	-400mV
V_{pp}	11.4V	780V
V_{top}	5.4V	346mV
V_{base}	-5.39V	-350mV

Multisim Value

Type	CH1	CH2
Pk-Pk	11.2V	748mV
Min	-5.61V	-374mV

Type	CH1	CH2
Max	5.62V	374V

Case 4: Vpp = 250 mV



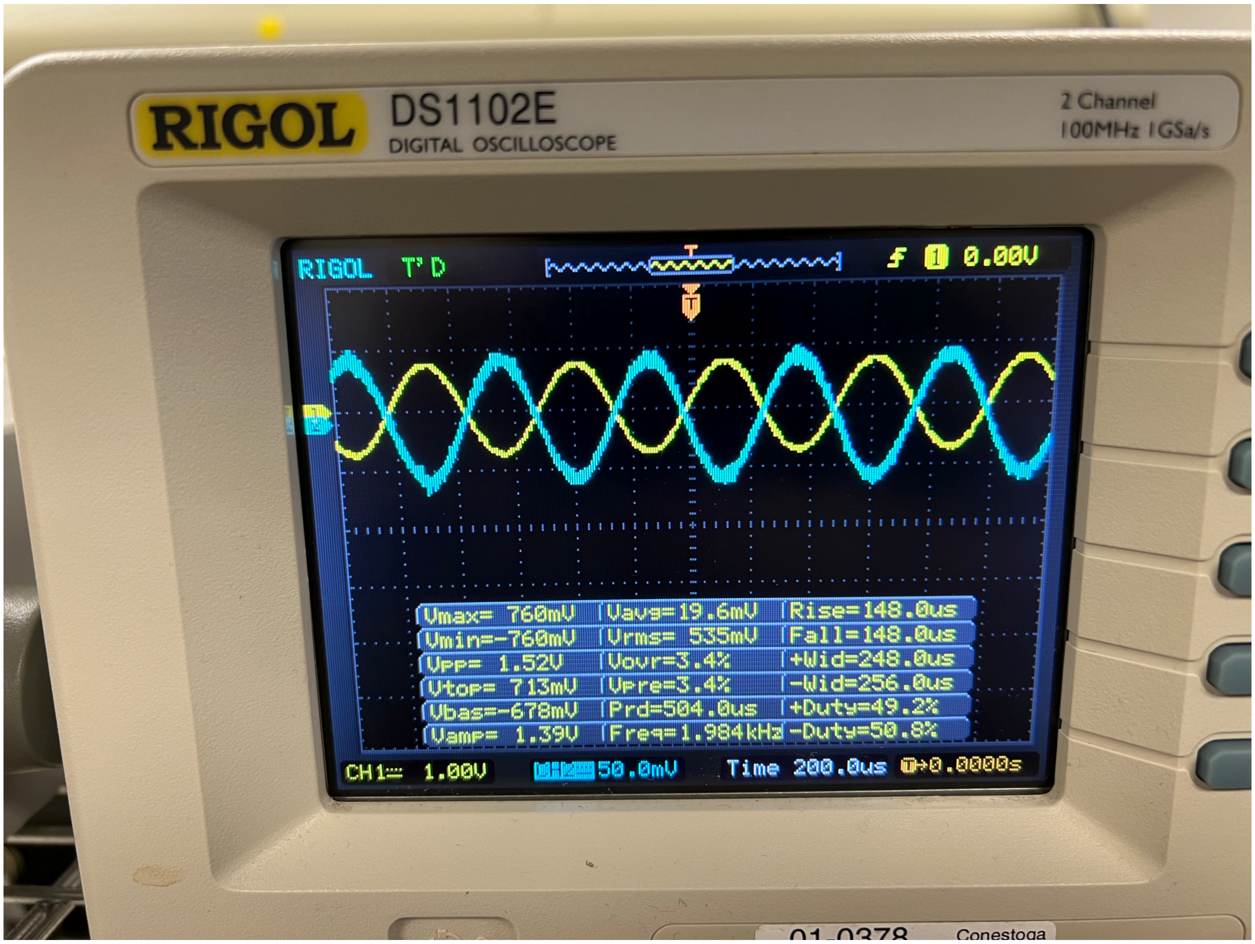
Real Value

Type	CH1	CH2
V_{max}	2V	120mV
V_{min}	-2.2V	-140mV
V_{pp}	4.2V	260mV
V_{top}	1.73V	88.4mV
V_{base}	-1.68V	-109mV

Multisim Value

Type	CH1	CH2
Pk-Pk	3.75V	250mV
Min	-1.87V	-125mV
Max	1.88V	125mV

Case 5: Vpp = 100 mV



Real Value

Type	CH1	CH2
V_{max}	760mV	58mV
V_{min}	-760mV	-56V
V_{pp}	1.52V	114mV
V_{top}	713V	50.5mV
V_{base}	-678V	-48.8mV

Multisim Value

Type	CH1	CH2
Pk-Pk	1.5V	99.9mV

Type	CH1	CH2
Min	-746mV	-49.9mV
Max	752mV	49.9mV

Input:

Case 1: Vpp = 1.0V
Case 2: Vpp = 500mV
Case 3: Vpp = 750mV
Case 4: Vpp = 250mV
Case 5: Vpp = 100mV

Observations:

From the observation we can see that the Vout will remain the same even if the Vin is changed and the gain will always be 15 has the Vin is the same for both resistors and the gain is 10 and 5 which added together we get 15.

Calculations:

$R_f = - R_i * A_{cl(I)1} = - 10K \text{ ohm} * 10 = - 100K \text{ ohm}$
$R_{i2} = - R_f/A_{cl(1)2} = - (-100K \text{ ohm})/ 5 = 20K \text{ ohm}$
Case 1:

$A_{cl(I)1} = - R_f/R_i$
$A_{cl(I)1} = - 100K/10K = 10$
$A_{cl(I)2} = - 100K/20K = 5$
$V_{out} = V_{in} \text{ X } A_{cl(I)1} + V_{in} \text{ X } A_{cl(I)2}$
$V_{out} = 1V \text{ X } 10 + 1V \text{ X } 5$
$V_{out} = 10V + 5V = 15V$

Case 2:

$A_{cl(I)1} = - R_f/R_i$
$A_{cl(I)1} = - 100K/10K = 10$
$A_{cl(I)2} = - 100K/20K = 5$
$V_{out} = V_{in} \text{ X } A_{cl(I)1} + V_{in} \text{ X } A_{cl(I)2}$
$V_{out} = 500mV \text{ X } 10 + 500mV \text{ X } 5$
$V_{out} = 5V + 2.5V = 7.5V$

Case 3:

$A_{cl(I)1} = - R_f/R_i$
$A_{cl(I)1} = - 100K/10K = 10$
$A_{cl(I)2} = - 100K/20K = 5$
$V_{out} = V_{in} \text{ X } A_{cl(I)1} + V_{in} \text{ X } A_{cl(I)2}$
$V_{out} = 750mV \text{ X } 10 + 750mV \text{ X } 5$
$V_{out} = 7.5V + 3.75V = 11.25V$

Case 4:

$A_{cl(I)1} = - R_f/R_i$

$A_{cl(I)1} = - 100K/10K = 10$

$A_{cl(I)2} = - 100K/20K = 5$

$V_{out} = V_{in} X A_{cl(I)1} + V_{in} X A_{cl(I)2}$

$V_{out} = 250mV X 10 + 250mV X 5$

$V_{out} = 2.5V + 1.25V = 3.75V$

Case 5:

$A_{cl(I)1} = - R_f/R_i$

$A_{cl(I)1} = - 100K/10K = 10$

$A_{cl(I)2} = - 100K/20K = 5$

$V_{out} = V_{in} X A_{cl(I)1} + V_{in} X A_{cl(I)2}$

$V_{out} = 100mV X 10 + 100mV X 5$

$V_{out} = 1V + 500mV = 1.5V$

Theory Vs Practical:

If we look at the values from multisim and the actual values from the ocilloscope we can see that the values we get in practical the lower the Vpp the function generator tends to overshoot, while the higher the Vpp the more the values remain the same. However in multisim the values are usually less than the actual values we get from the function generator.

Conclusions:

We can finally conclude that if the Vin if same for both resistors than the gain will always be 15 and the output will amplify by 15. We used multiple different Vin and the results can be said to be similar to the multisim and the one we calculated using the formula.