Signal and System

Assignment

• Group Members:	Enrollment Number:
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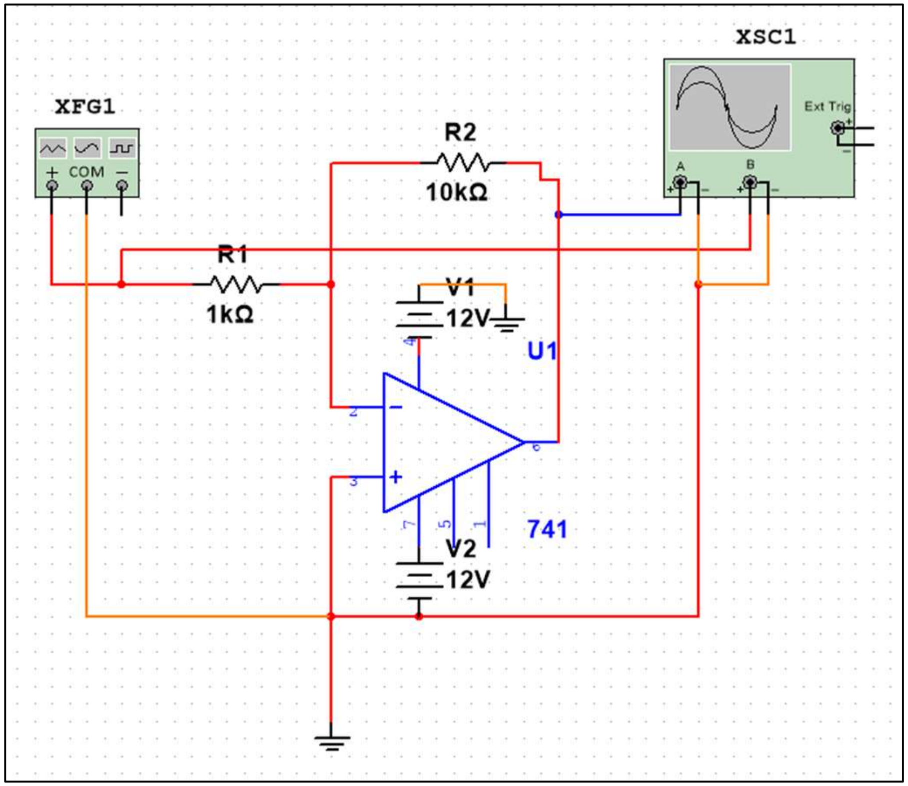
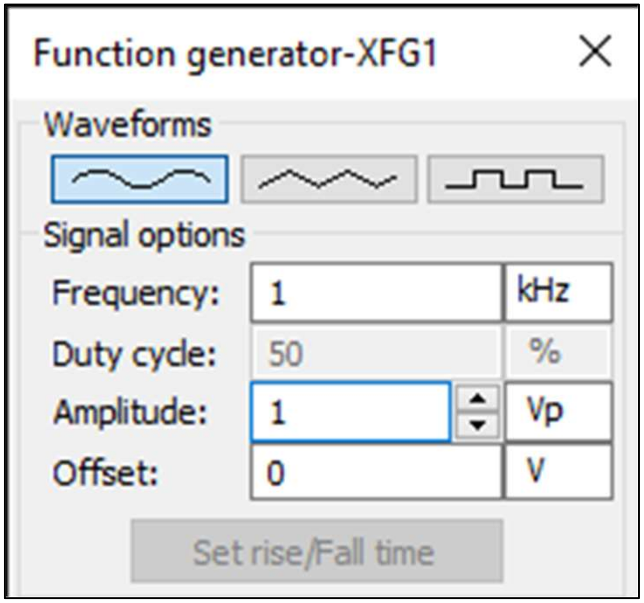
1) First of all, implement a simple inverting amplifier. Check whether the gain (V_out/V_in) remains linear over a range of input voltage. Try to plot the gain against a swing of input voltage for this.

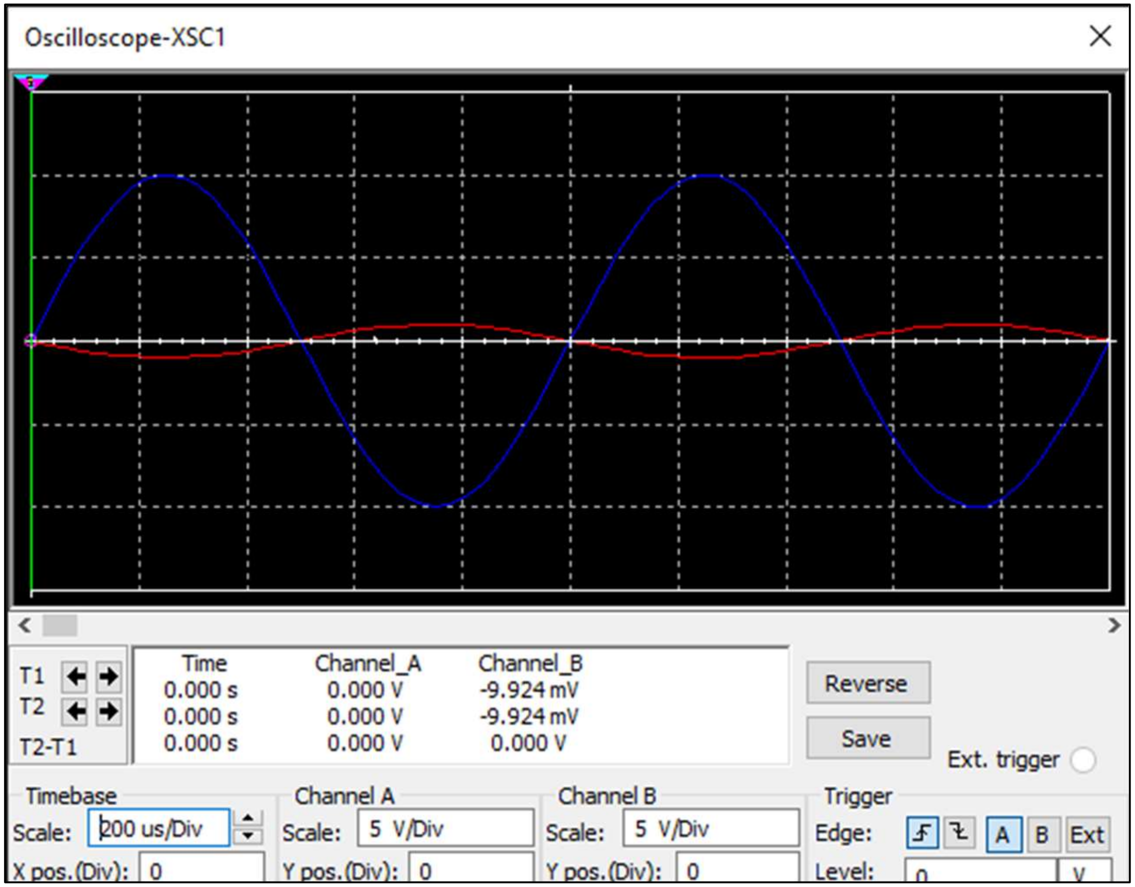
- Circuit:



- Input:1


Function generator-XFG1
Waveforms
Signal options
Frequency:
1
kHz
Duty cycle:
50
%
Amplitude:
1
Vp
Offset:
0
V
Set rise/Fall time

- Output :1

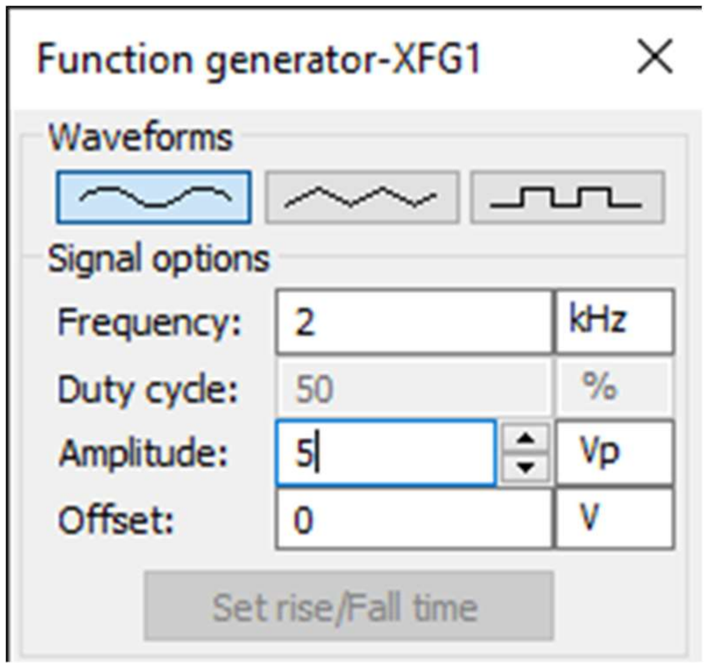


Oscilloscope-XSC1
T1
T2
T2-T1
Time
0.000 s
0.000 s
0.000 s
Channel_A
0.000 V
0.000 V
0.000 V
Channel_B
-9.924 mV
-9.924 mV
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 200 us/Div
X pos.(Div): 0
Channel A
Scale: 5 V/Div
Y pos.(Div): 0
Channel B
Scale: 5 V/Div
Y pos.(Div): 0
Trigger
Edge:
A
B
Ext
Level: 0 V

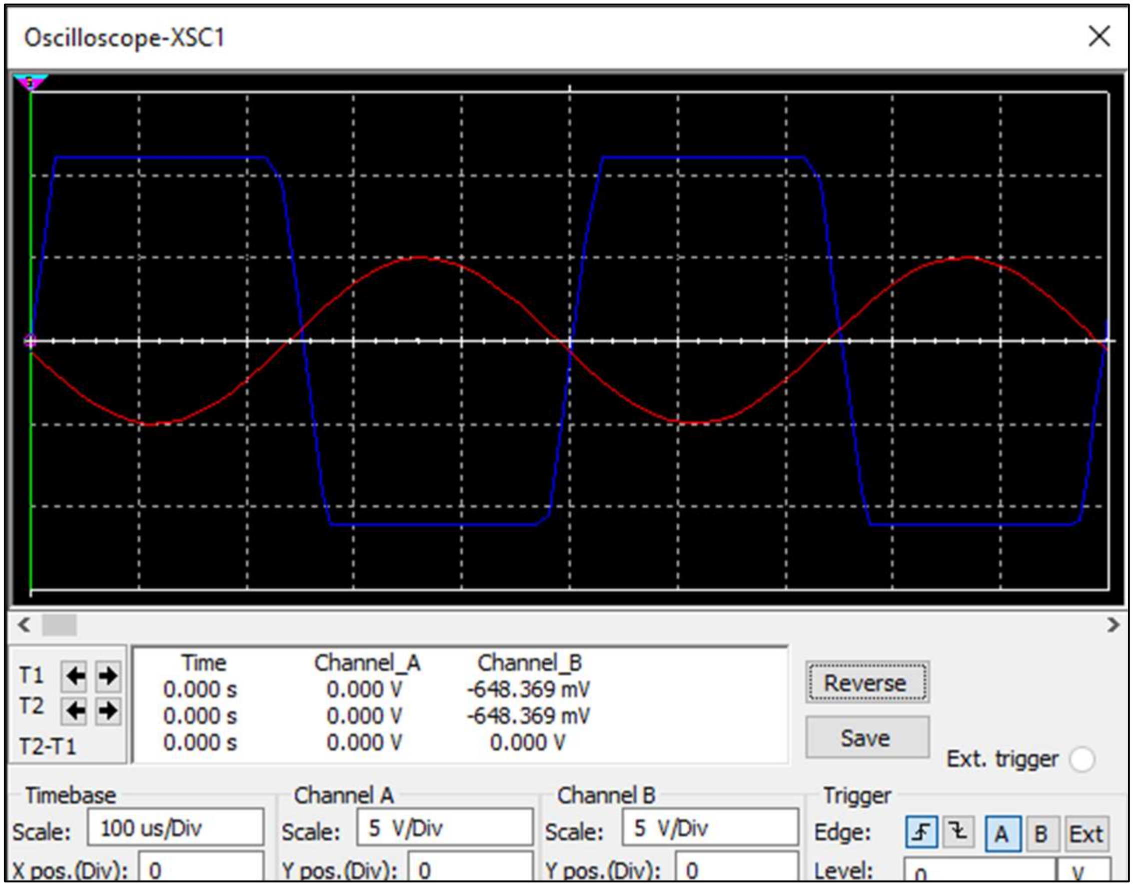
Explanation to Output

- As R1 = 1kOhm and R2 = 10kOhm
- Proportionality Factor = - 10/1 = -10
- Hence the output will be inverted and scaled 10 time

- Input :2


Function generator-XFG1
Waveforms
Signal options
Frequency:
2
kHz
Duty cycle:
50
%
Amplitude:
5
Vp
Offset:
0
V
Set rise/Fall time

- Output :2



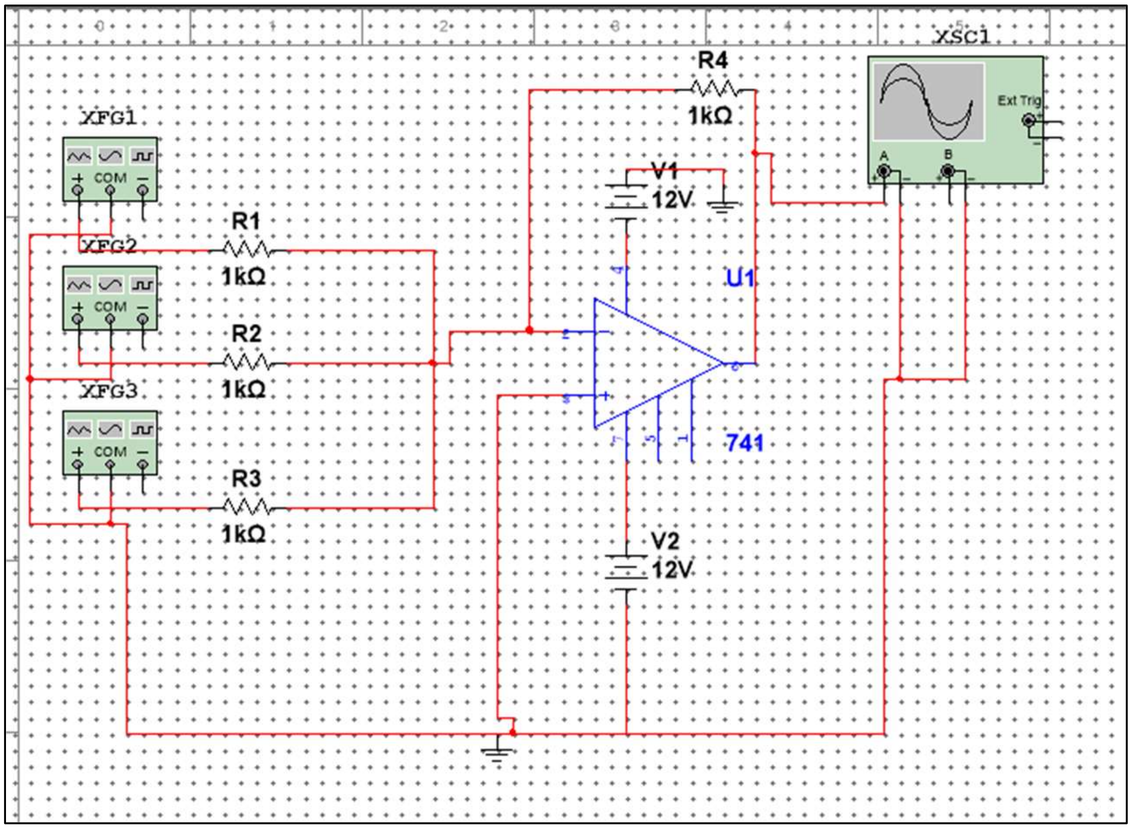
Oscilloscope-XSC1
T1
T2
T2-T1
Time
0.000 s
0.000 s
0.000 s
Channel_A
0.000 V
0.000 V
0.000 V
Channel_B
-648.369 mV
-648.369 mV
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 100 us/Div
X pos.(Div): 0
Channel A
Scale: 5 V/Div
Y pos.(Div): 0
Channel B
Scale: 5 V/Div
Y pos.(Div): 0
Trigger
Edge:
A
B
Ext
Level: 0
V

Explanation to Output

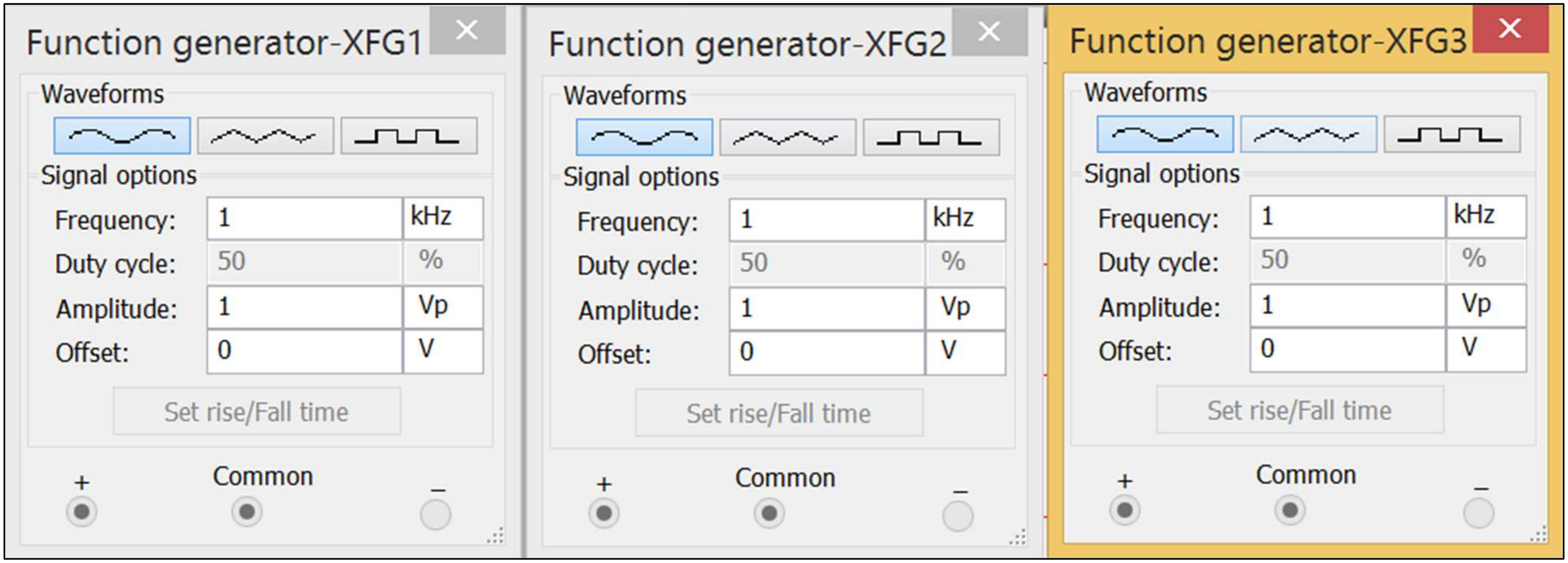
- Proportionality Factor = -10
- But as V_in has Amplitude 5, V_out will have Amplitude 50
- But the opamp cant amplify past 12V
- So any value above 12V will be displayed as 12V only

2) Then implement few designer opamps that produce a linear combination of two input voltages at the output. Check different alternatives like sum and differences.

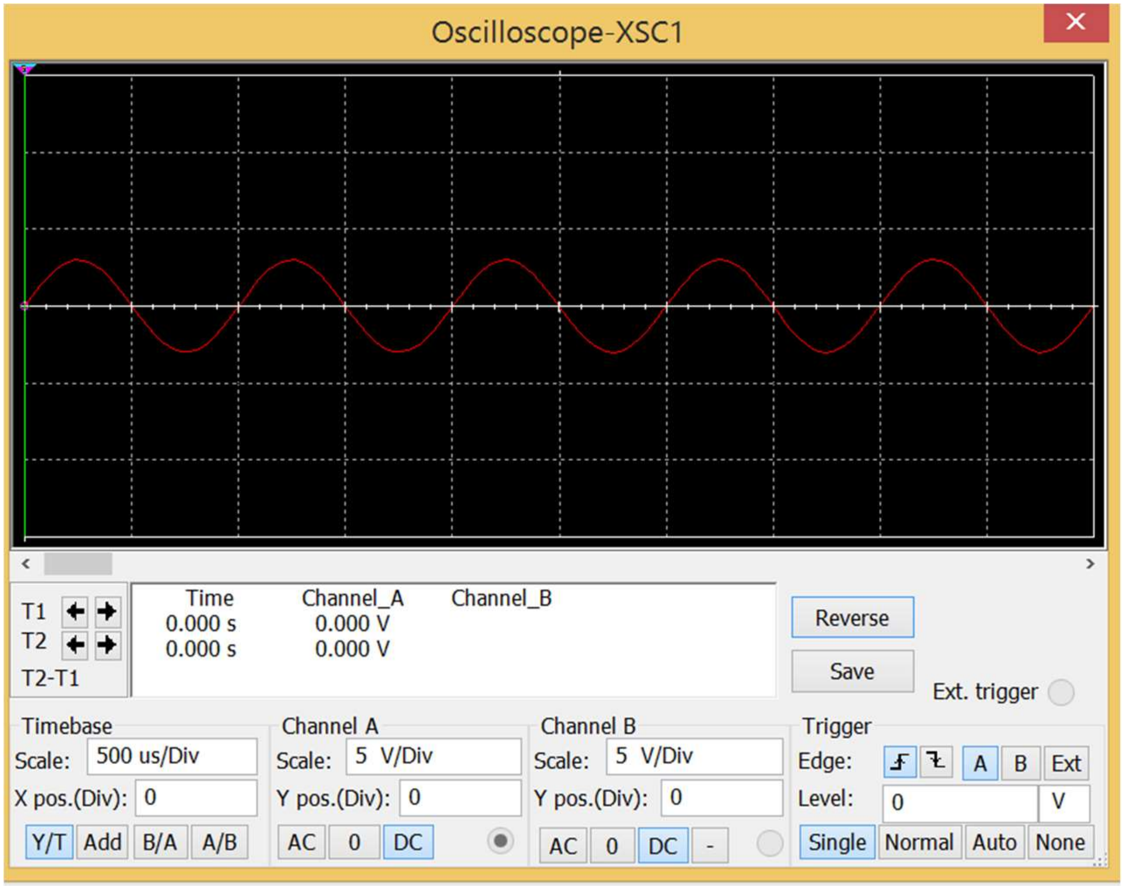
- Addition circuit:



- Addition input:



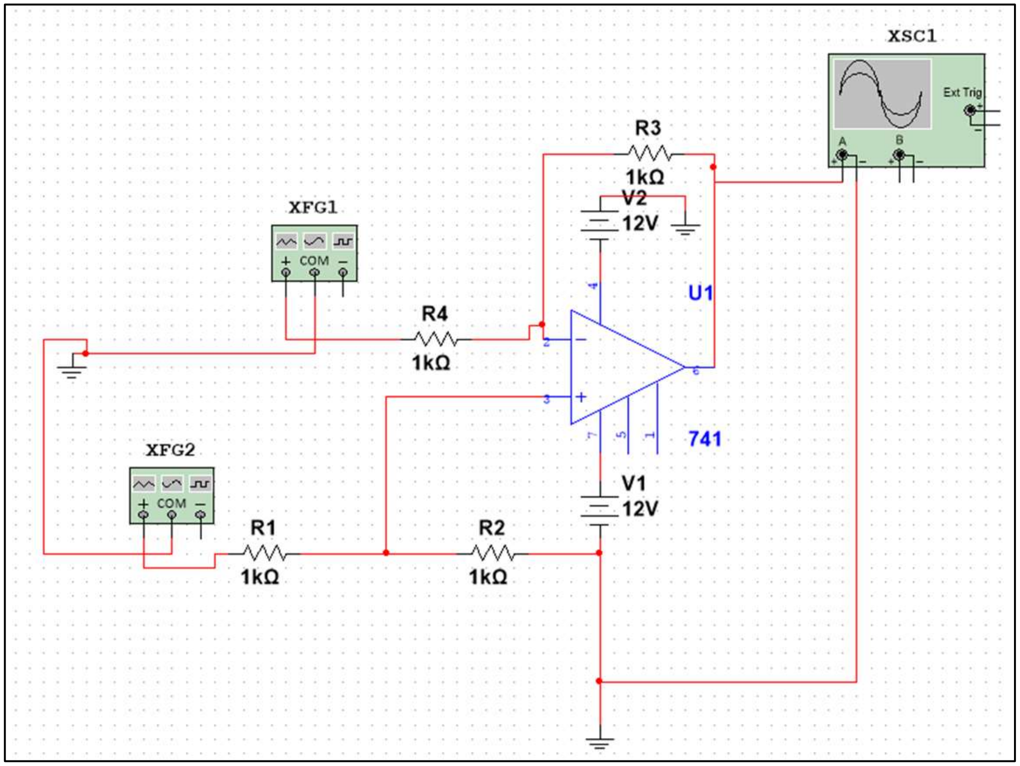
- Addition output:



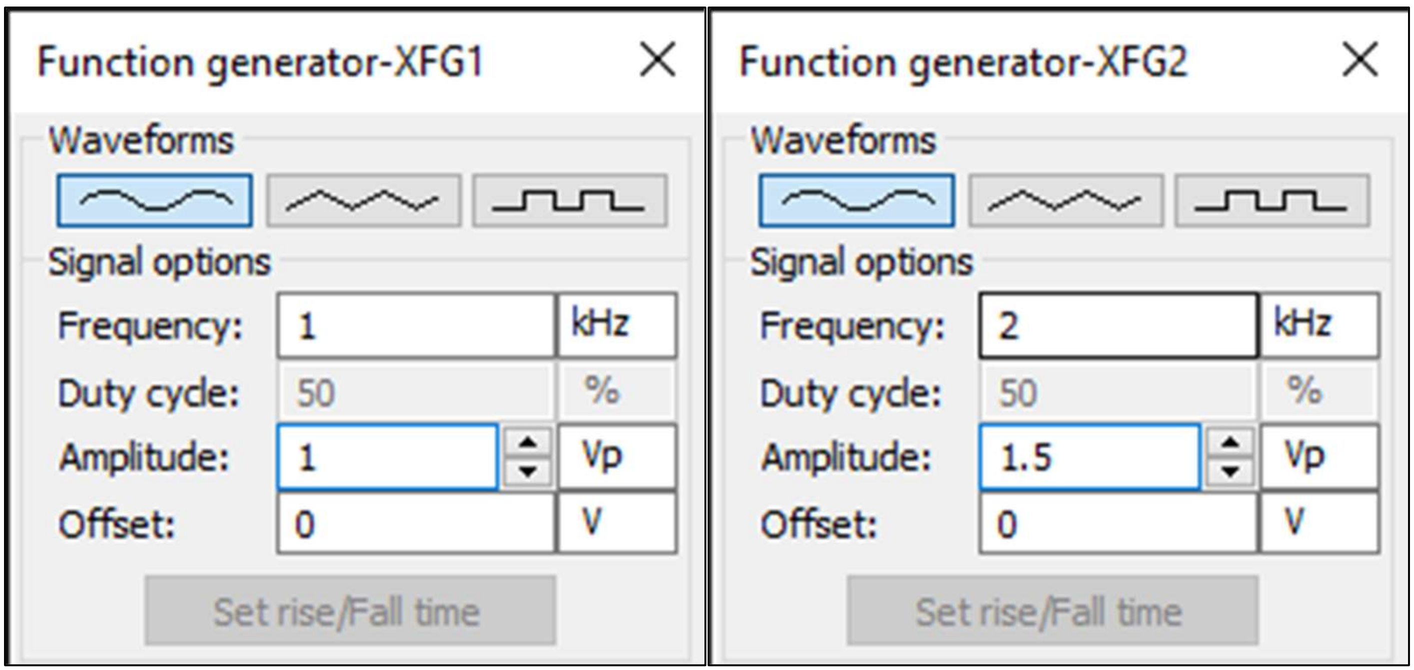
Explanation to Output

- As all of the three inputs have amplitude 1 and frequent 1kHz, The Output will have Amplitude 3 and same frequency

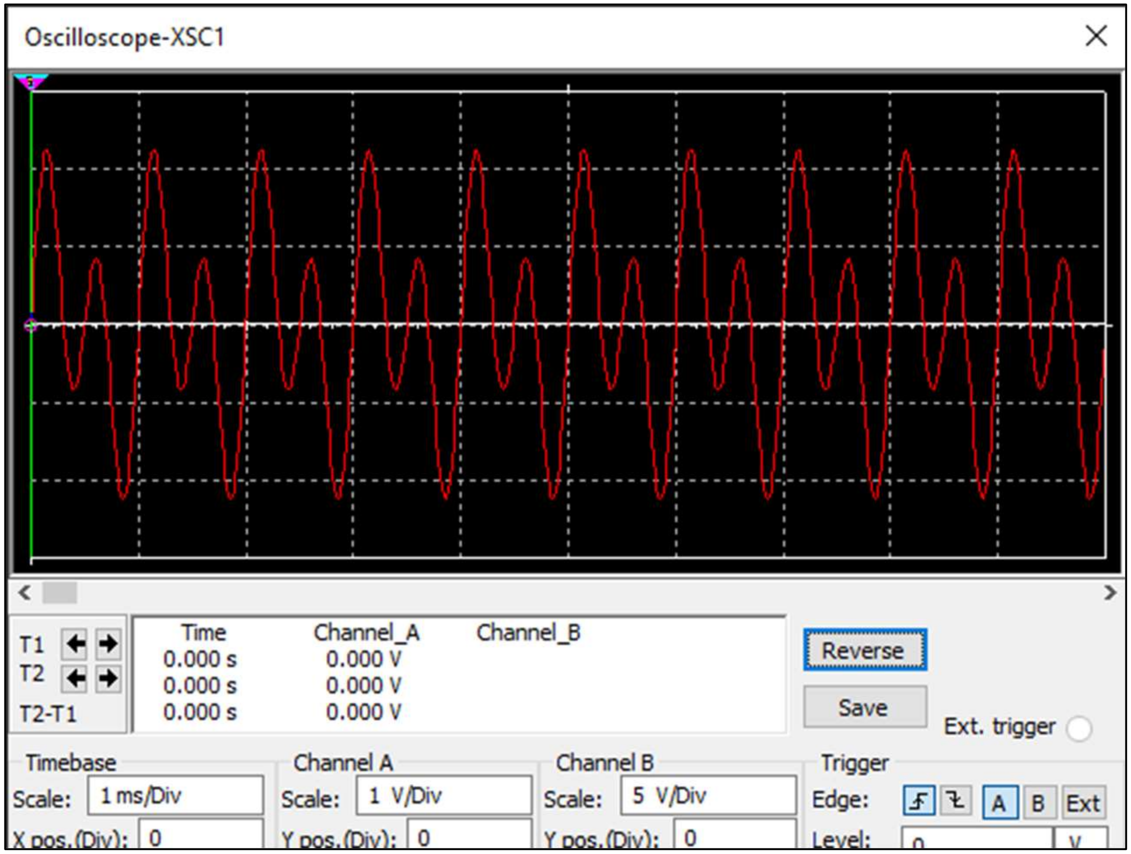
- Subtraction circuit:



- Subtractor input:



- Output:

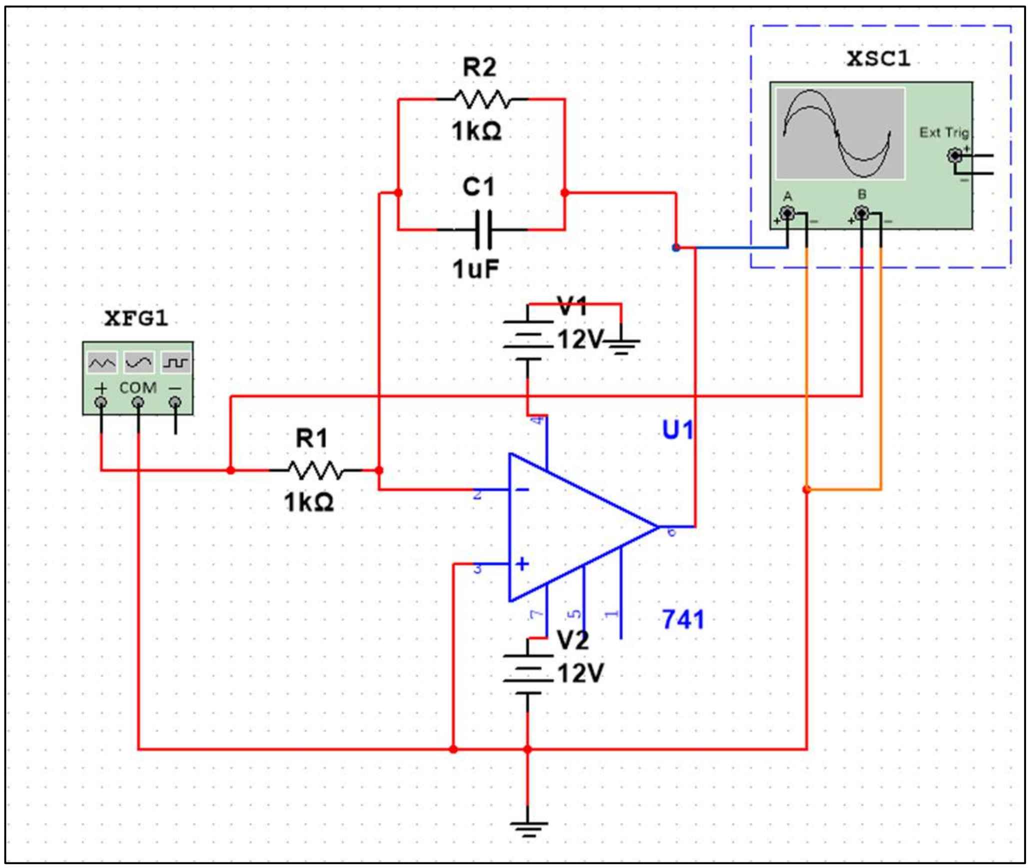

Oscilloscope-XSC1
T1
T2
T2-T1
Time
0.000 s
0.000 s
0.000 s
Channel_A
0.000 V
0.000 V
0.000 V
Channel_B
Reverse
Save
Ext. trigger
Timebase
Scale: 1 ms/Div
X pos.(Div): 0
Channel A
Scale: 1 V/Div
Y pos.(Div): 0
Channel B
Scale: 5 V/Div
Y pos.(Div): 0
Trigger
Edge:
A
B
Ext
Level: 0
V

Explanation to Output

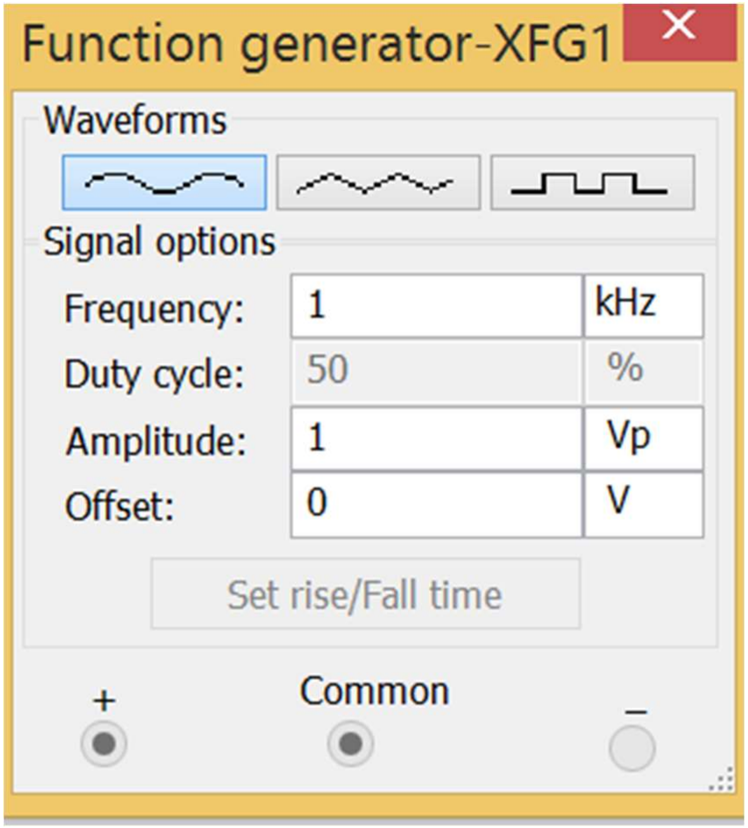
- As both of the input has different frequency and Amplitude, The output will be superposition of their graphs

3) Now implement the integrator circuit and also the PI circuit. Check the output for different input voltage profiles.

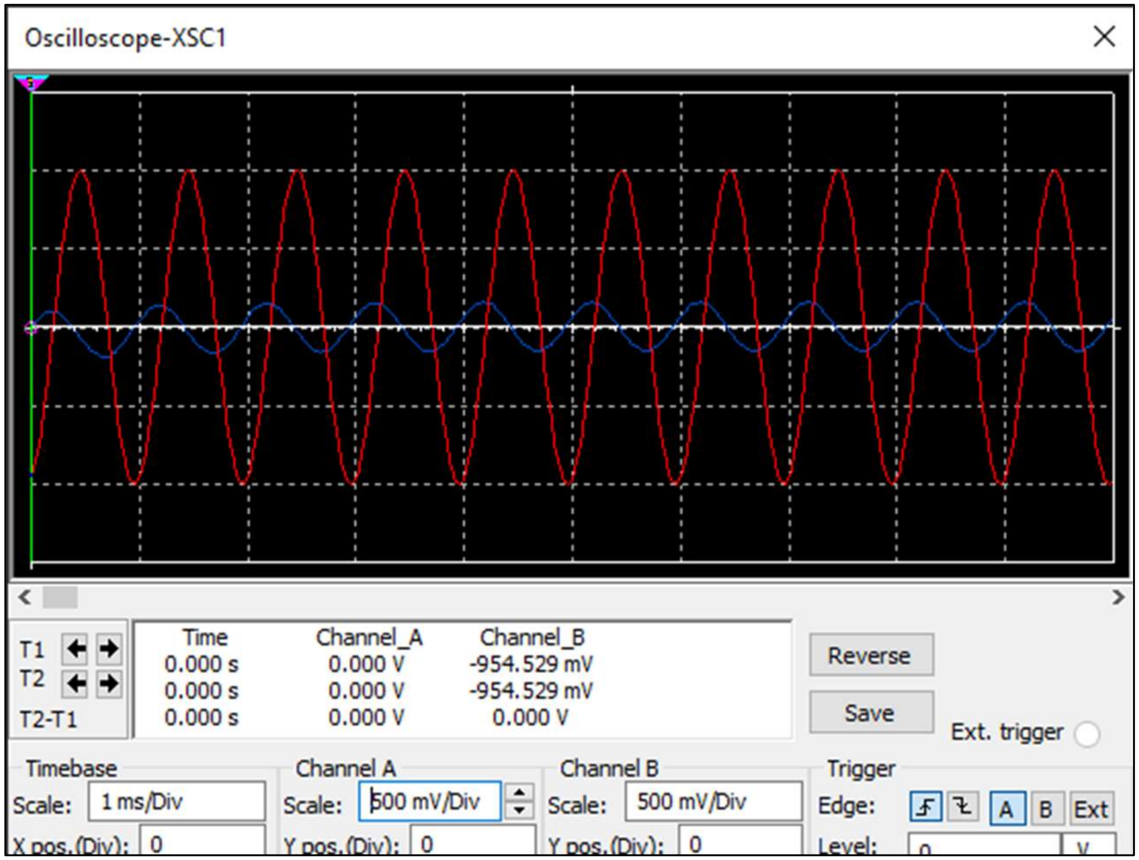
- Integrator circuit:



- Integrator Input:



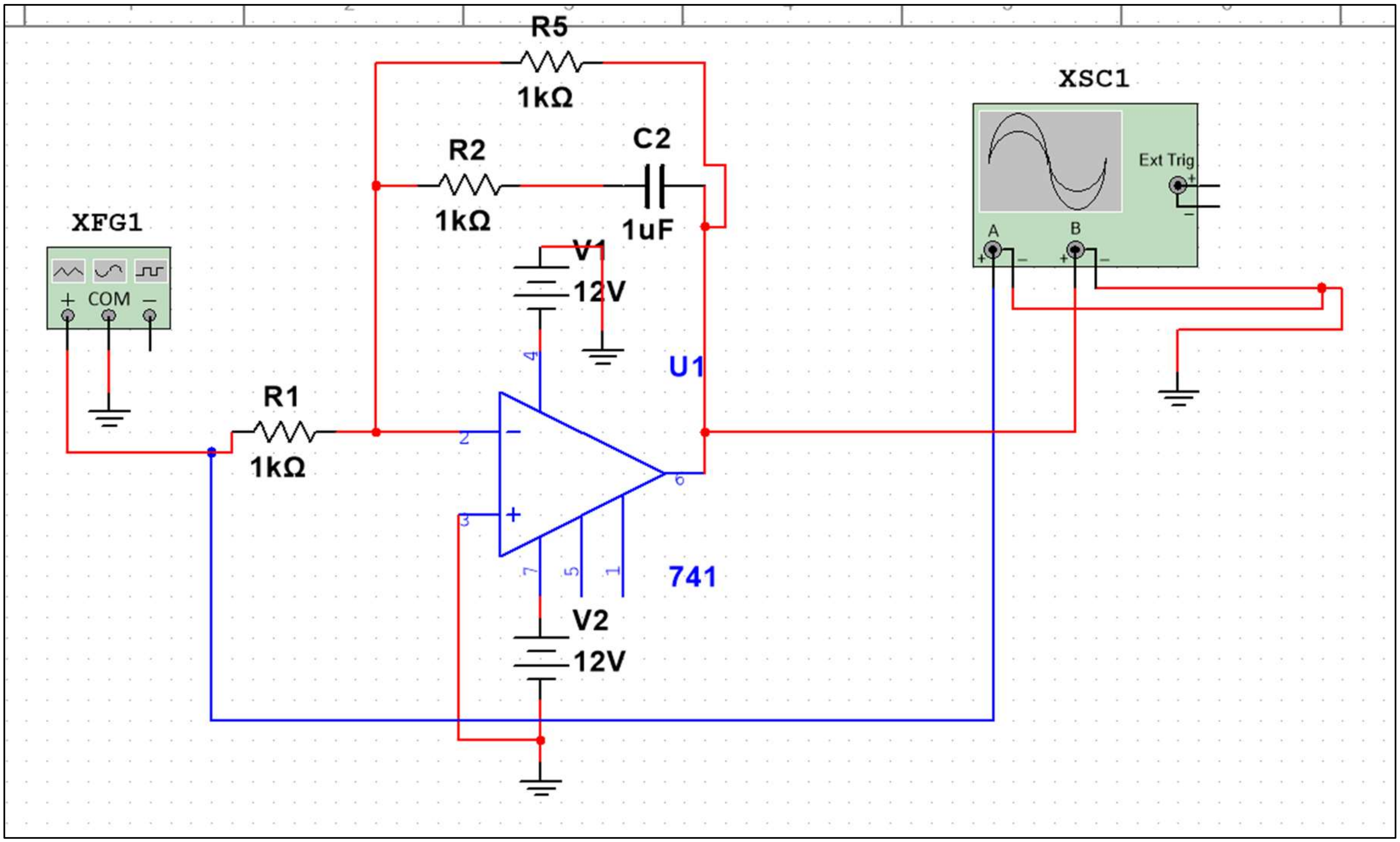
- Integrator Output:



Explanation of Output

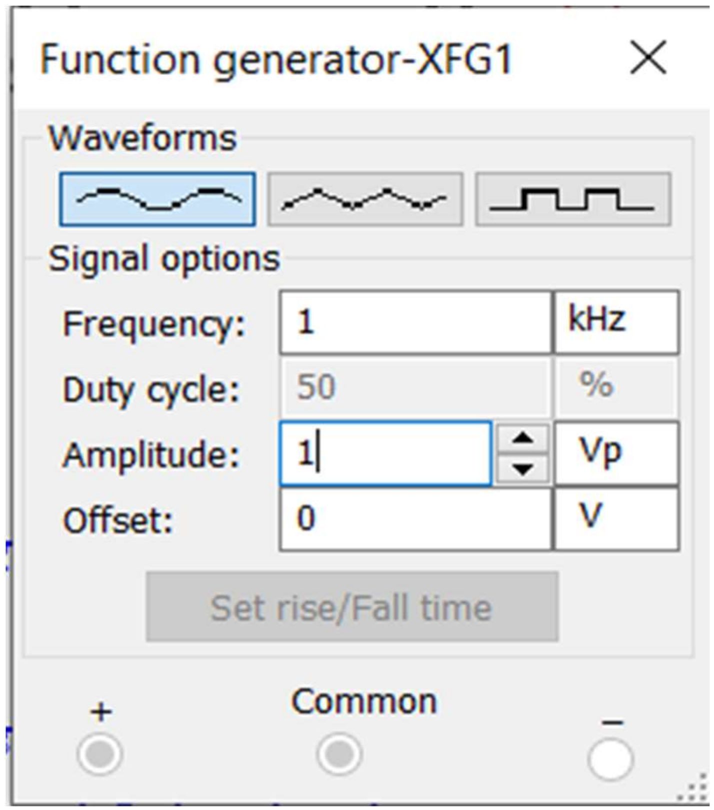
- As $\int \sin(2\pi f t) = \cos(2\pi f t)\,/2\pi f$
- The output graph will be a cos function, but scaled down by a factor of $2\pi f$
- It means when input is in its peak / valley, the output will be zero

- PI Circuit:

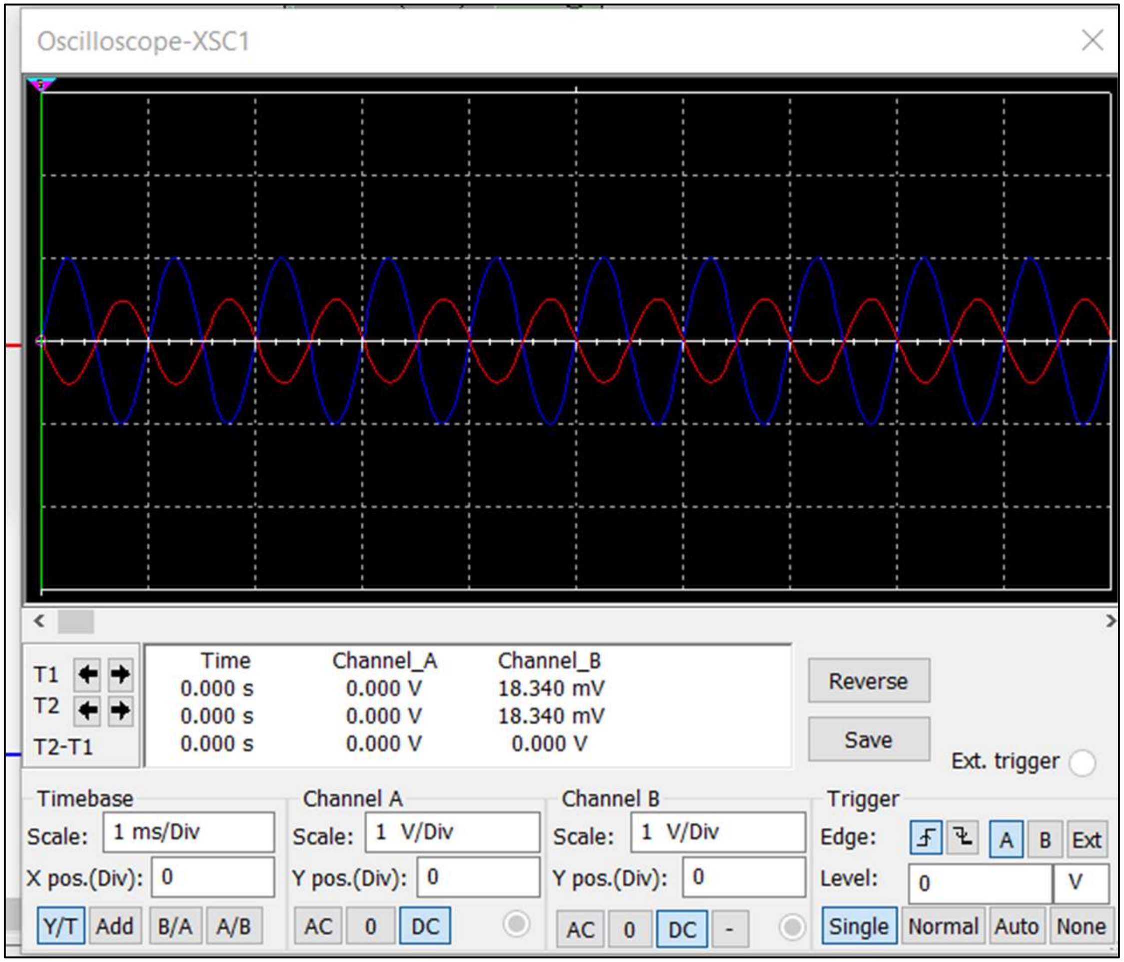


R5
1kΩ
R2
1kΩ
C2
1uF
XSC1
Ext Trig
A
B
XFG1
COM
V1
12V
U1
R1
1kΩ
741
V2
12V

- PI Input 1:

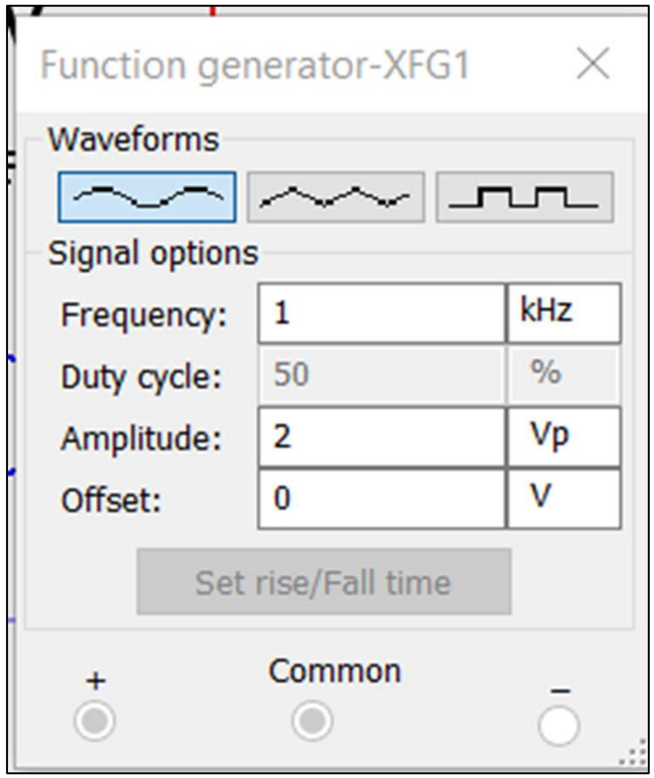

Function generator-XFG1
Waveforms
Signal options
Frequency:
1
kHz
Duty cycle:
50
%
Amplitude:
1
Vp
Offset:
0
V
Set rise/Fall time
+
Common
−

- PI Output 1:

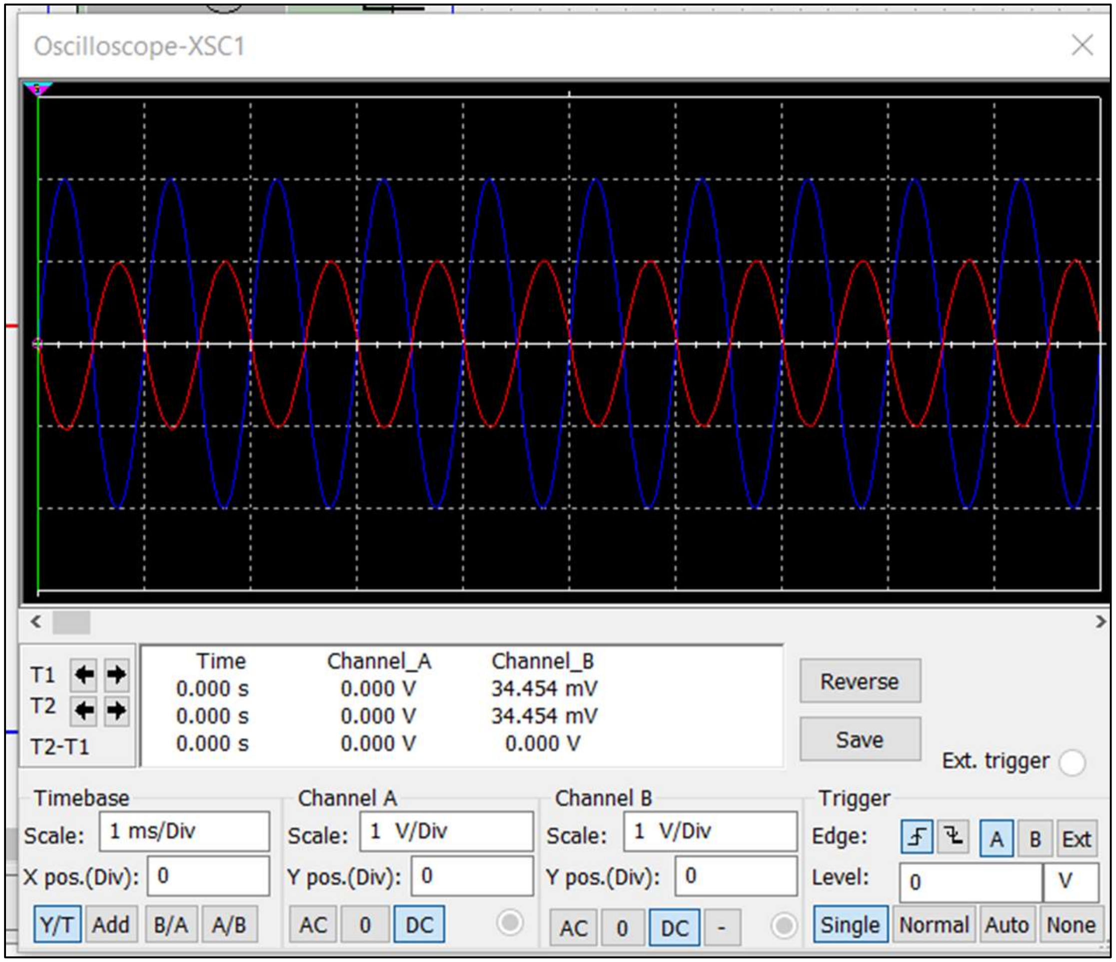


Oscilloscope-XSC1
Time
Channel_A
Channel_B
T1
0.000 s
0.000 V
18.340 mV
T2
0.000 s
0.000 V
18.340 mV
T2-T1
0.000 s
0.000 V
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 1 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 1 V/Div
Y pos.(Div): 0
AC 0 DC
Channel B
Scale: 1 V/Div
Y pos.(Div): 0
AC 0 DC -
Trigger
Edge:
A B Ext
Level: 0 V
Single Normal Auto None

- PI Input 2:


Function generator-XFG1
Waveforms
Signal options
Frequency:
1
kHz
Duty cycle:
50
%
Amplitude:
2
Vp
Offset:
0
V
Set rise/Fall time
+
Common
−

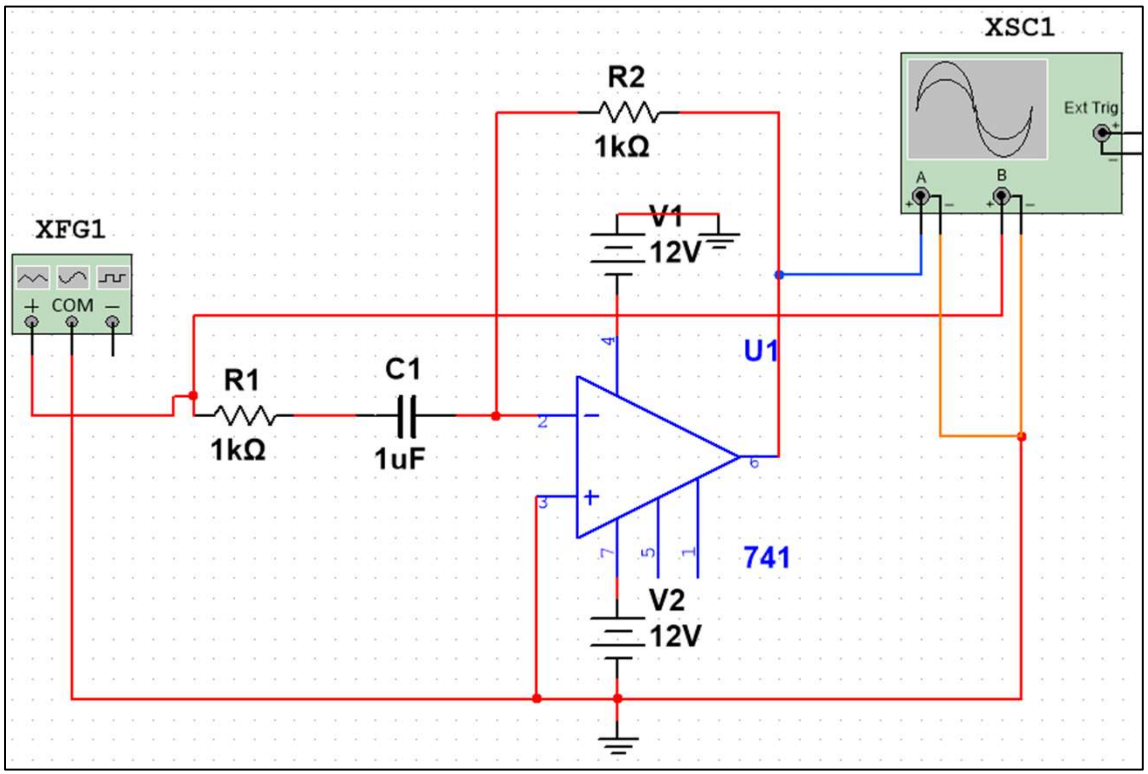
- PI Output 2:



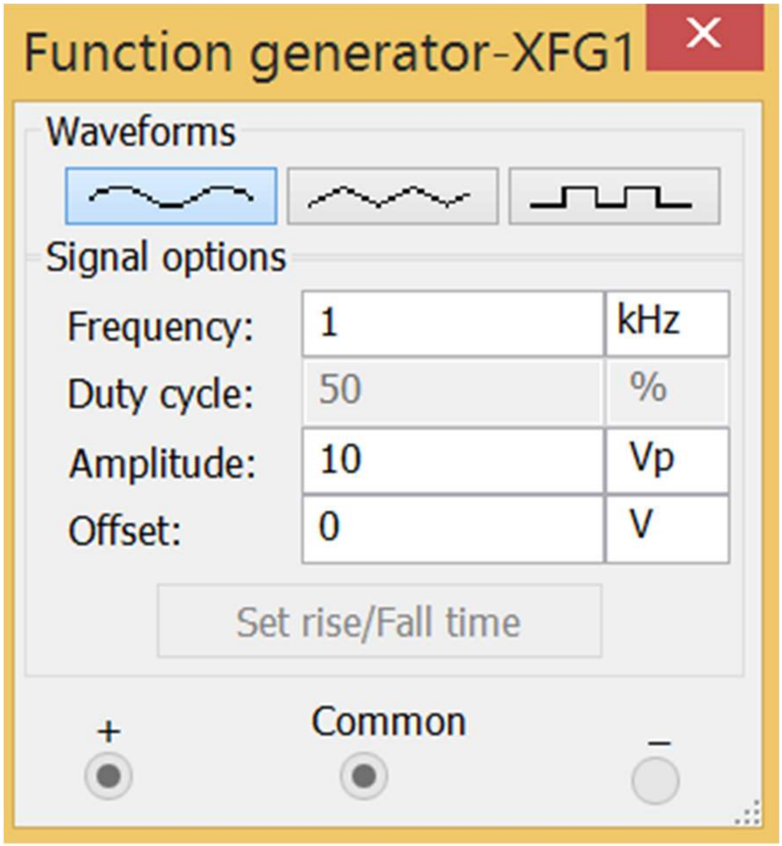
Oscilloscope-XSC1
T1
T2
T2-T1
Time
0.000 s
0.000 s
0.000 s
Channel_A
0.000 V
0.000 V
0.000 V
Channel_B
34.454 mV
34.454 mV
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 1 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 1 V/Div
Y pos.(Div): 0
AC 0 DC
Channel B
Scale: 1 V/Div
Y pos.(Div): 0
AC 0 DC -
Trigger
Edge:
A B Ext
Level: 0 V
Single Normal Auto None

4)Now implement the differentiator circuit and the PD circuit. Check the output for different input voltage profiles.

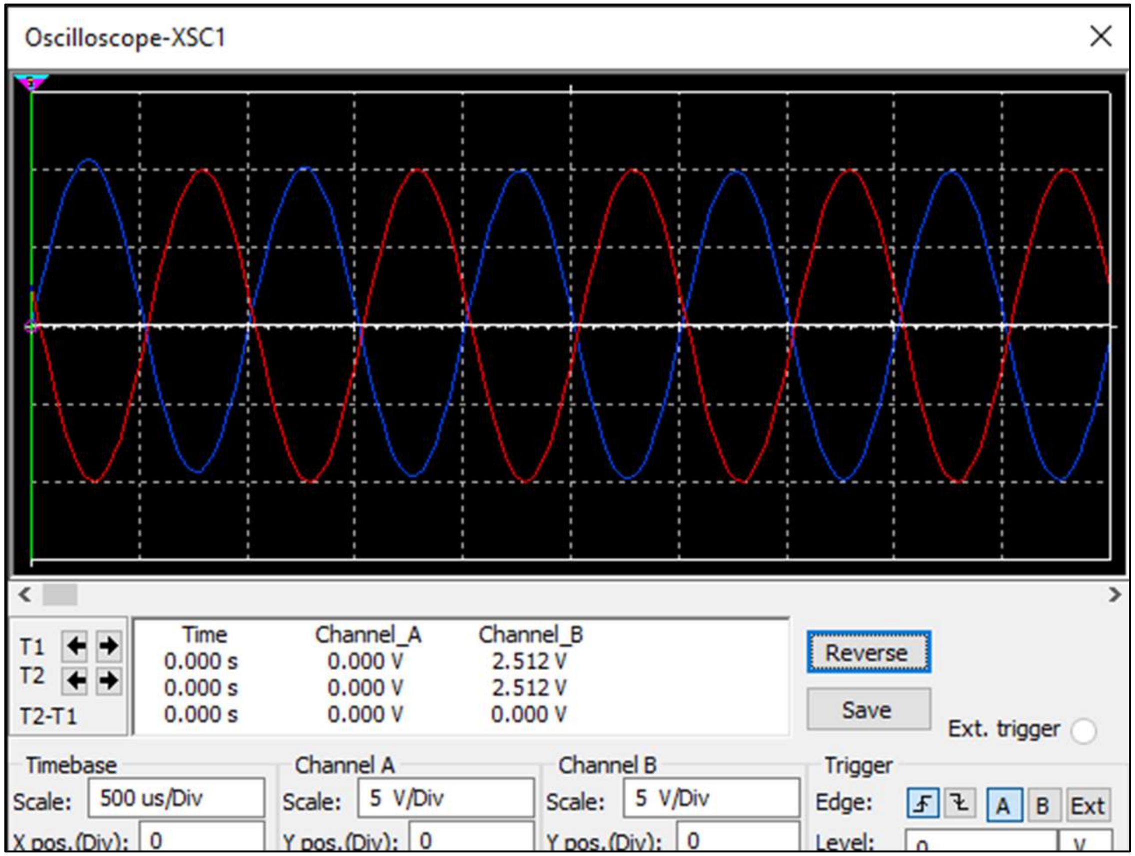
- Differentiator circuit:



- Differentiator input:



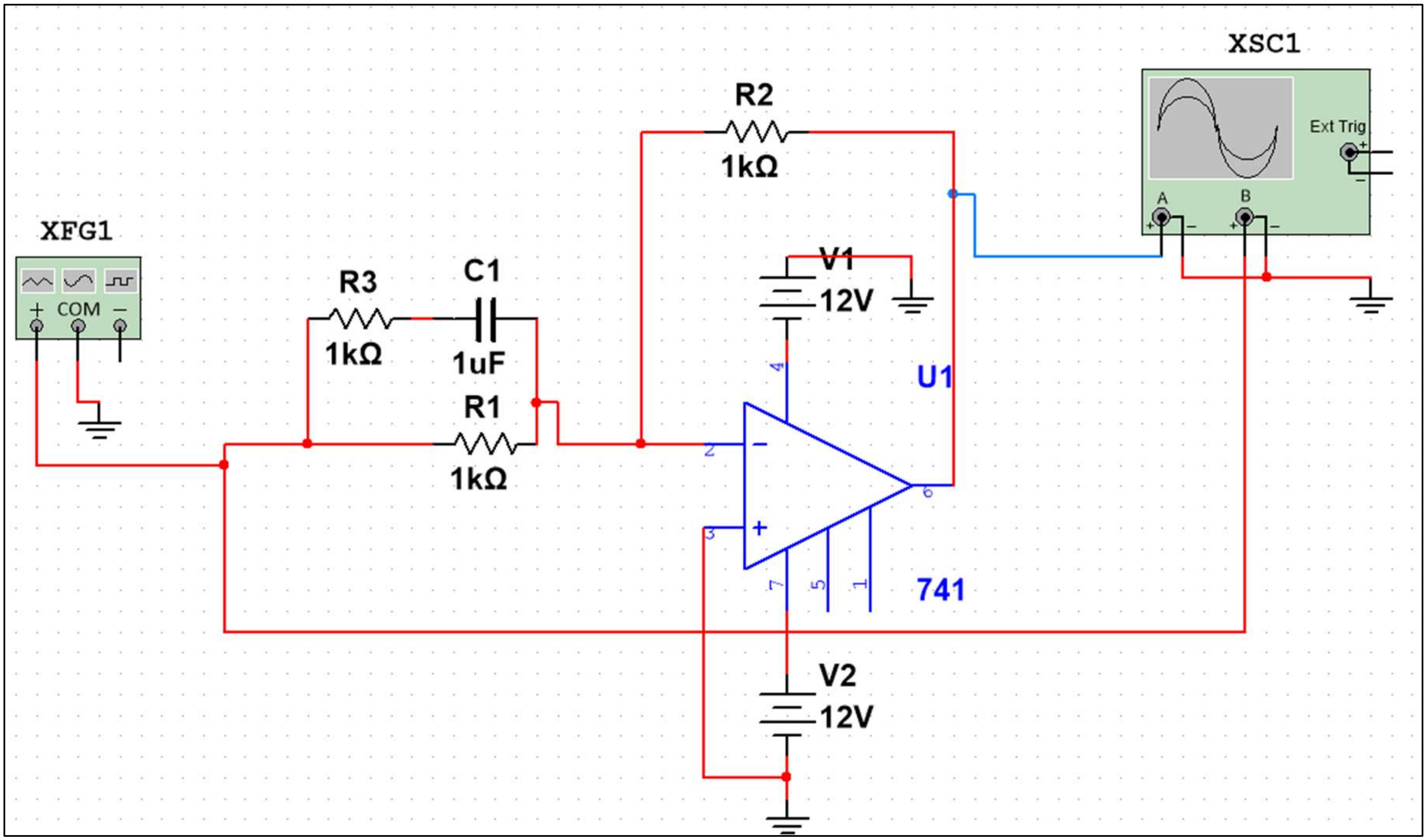
- Differentiator output:



Explanation of Output

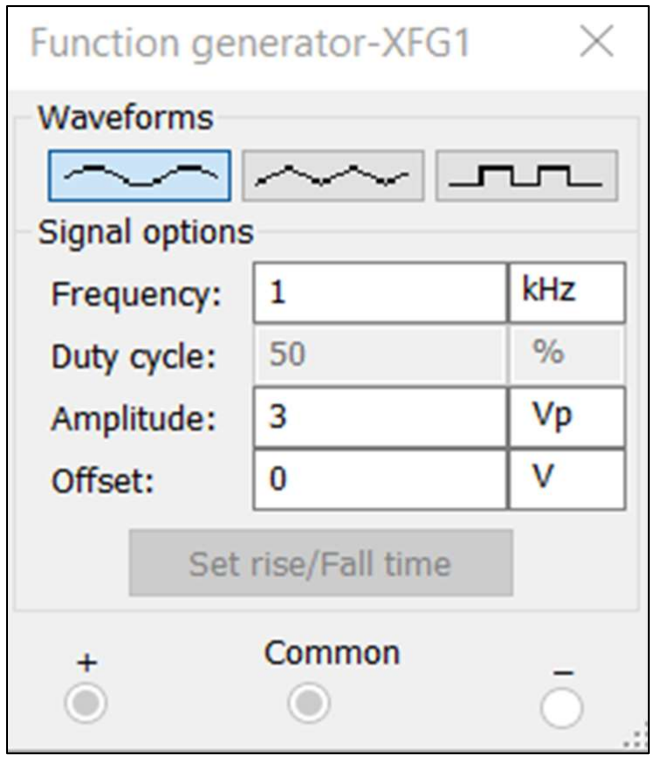
- As $\frac{d}{dt}\sin(2\pi ft) = 2\pi f cos(2\pi ft)$
- The output will be a cos function, scaled up by the value $2\pi f$
- But due to the values of Resistance and Capacitance of the circuit, the factor cancels, giving exact same amplitude as Input

- PD Circuit:

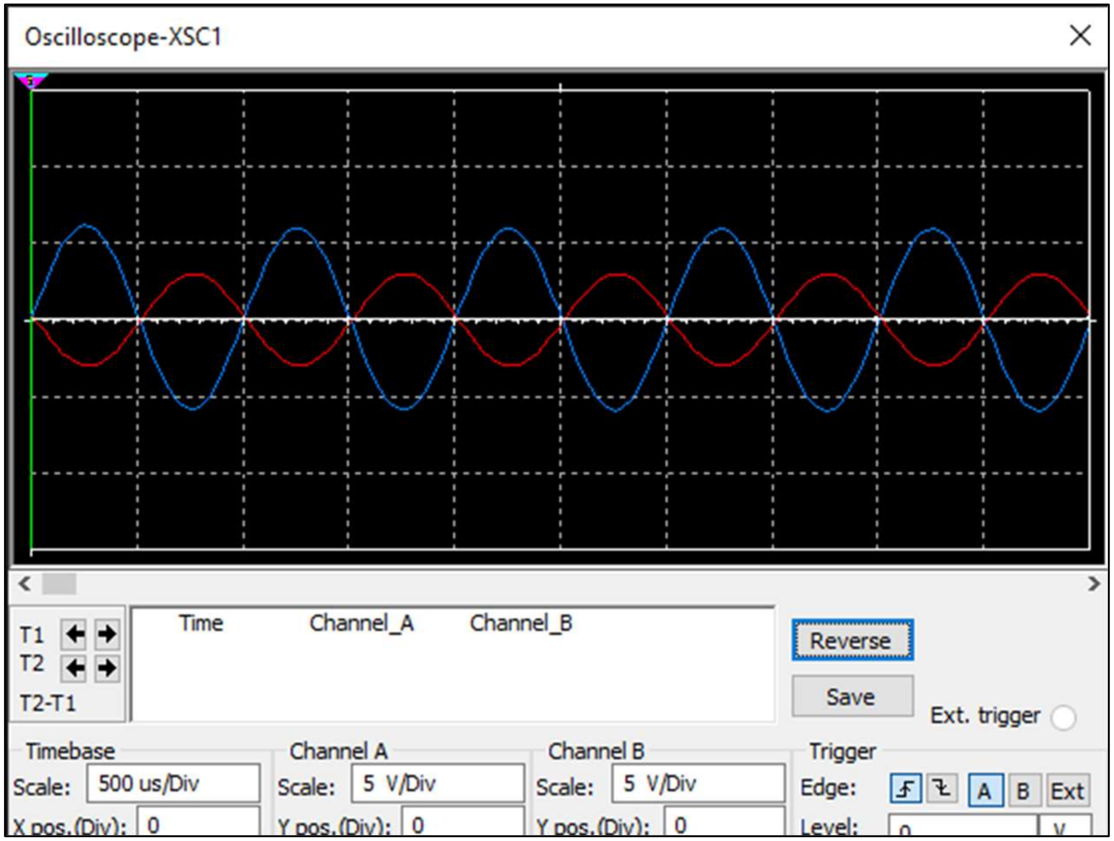


XSC1
Ext Trig
A
B
R2
1kΩ
XFG1
COM
R3
1kΩ
C1
1uF
R1
1kΩ
V1
12V
U1
741
V2
12V

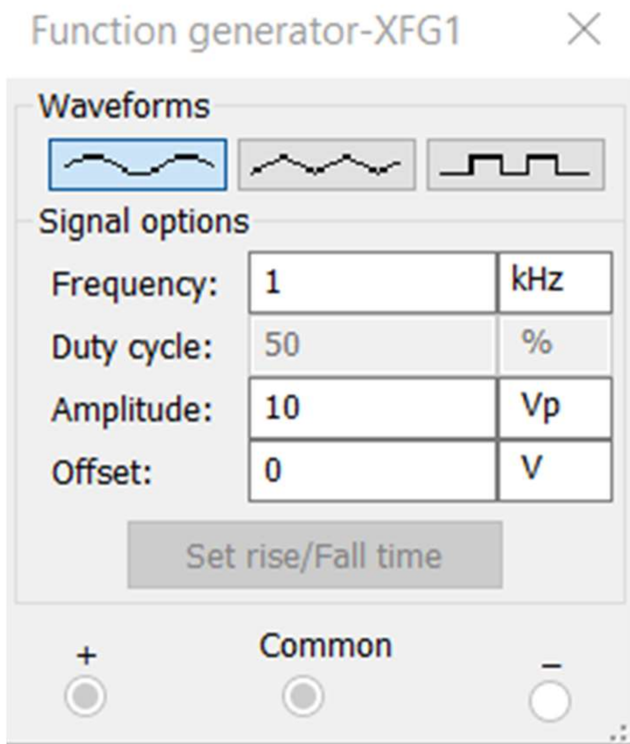
- PD Input 1:


Function generator-XFG1
Waveforms
Signal options
Frequency:
1
kHz
Duty cycle:
50
%
Amplitude:
3
Vp
Offset:
0
V
Set rise/Fall time
+
Common
−

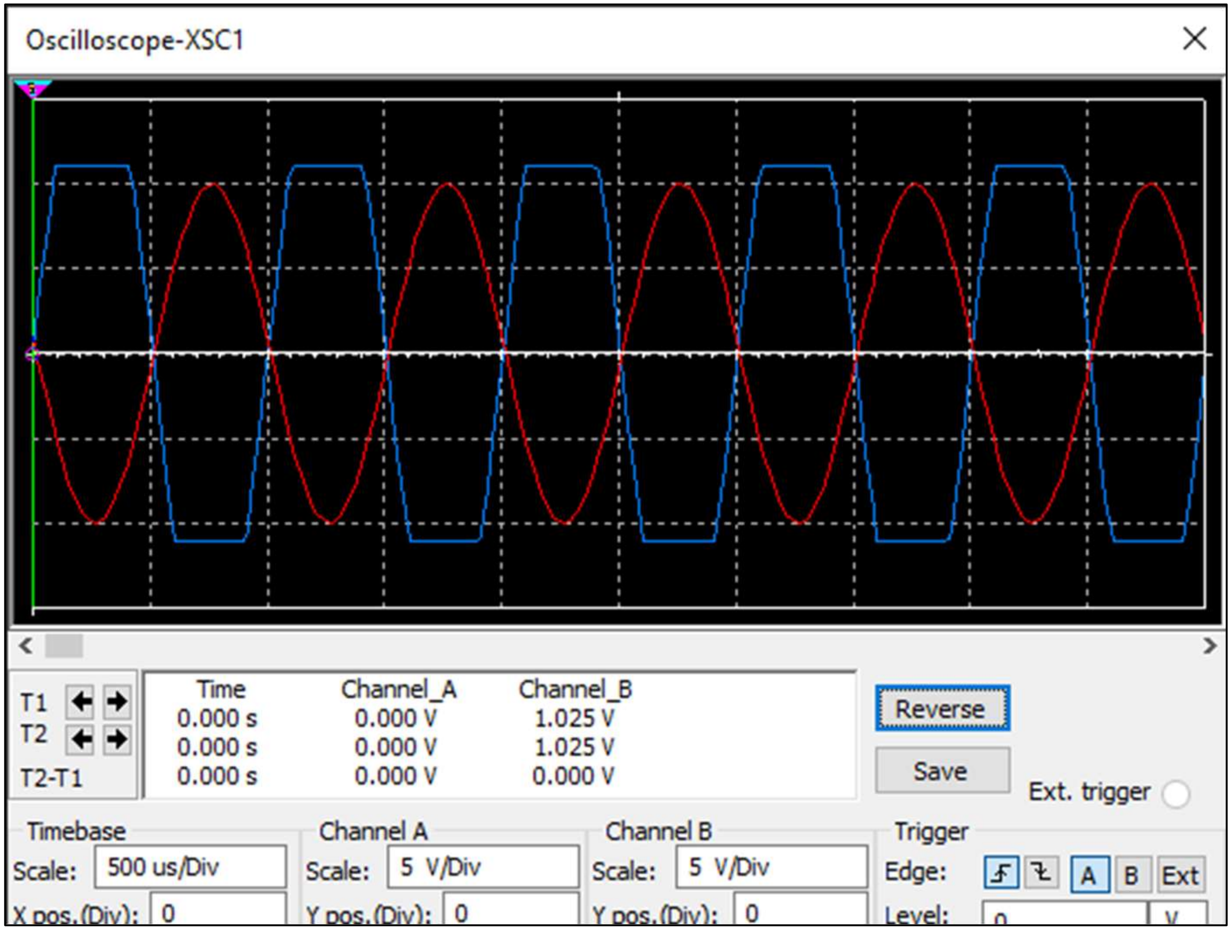
- PD Output 1:


Oscilloscope-XSC1
Time
Channel_A
Channel_B
T1
T2
T2-T1
Reverse
Save
Ext. trigger
Timebase
Scale: 500 us/Div
X pos.(Div): 0
Channel A
Scale: 5 V/Div
Y pos.(Div): 0
Channel B
Scale: 5 V/Div
Y pos.(Div): 0
Trigger
Edge:
A
B
Ext
Level: 0
V

- PD Input 2:

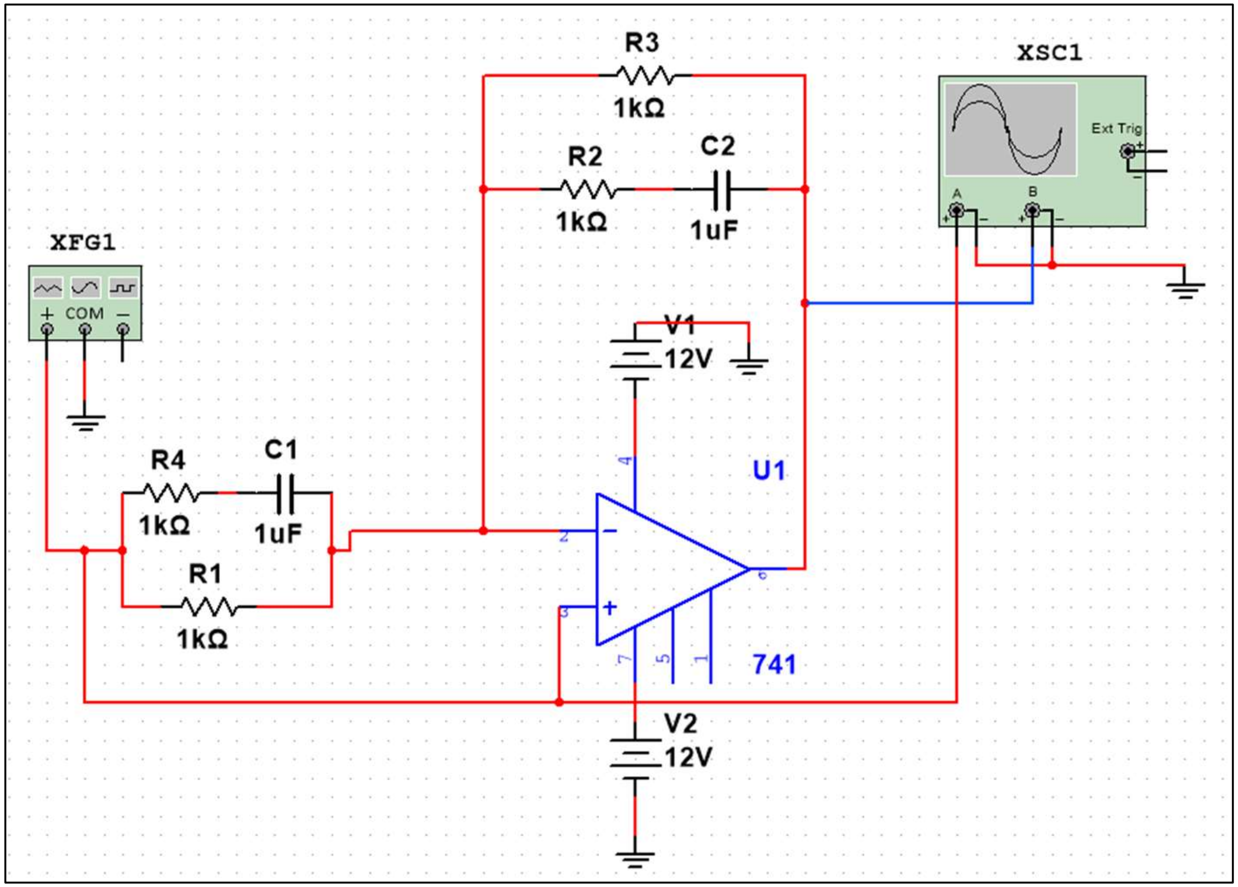

Function generator-XFG1
Waveforms
Signal options
Frequency:
1
kHz
Duty cycle:
50
%
Amplitude:
10
Vp
Offset:
0
V
Set rise/Fall time
+
Common
−

- PD Output 2:

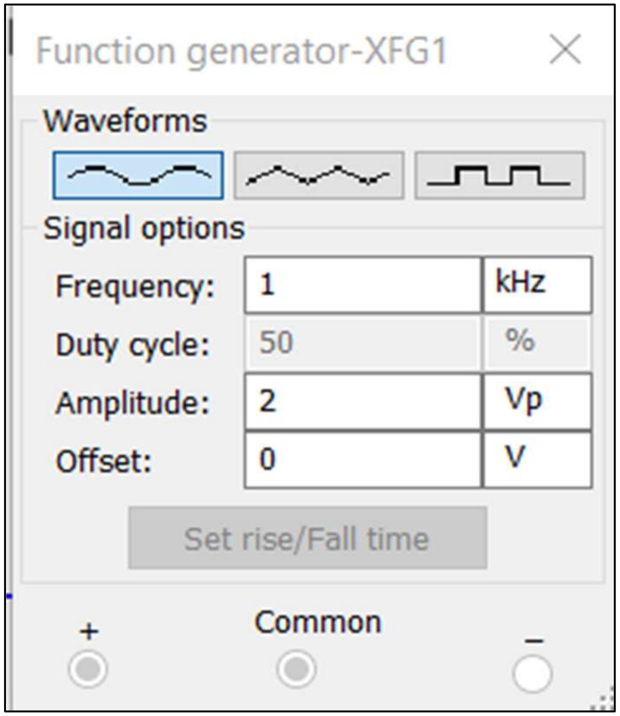

Oscilloscope-XSC1
Time
Channel_A
Channel_B
T1
0.000 s
0.000 V
1.025 V
T2
0.000 s
0.000 V
1.025 V
T2-T1
0.000 s
0.000 V
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 500 us/Div
X pos.(Div): 0
Channel A
Scale: 5 V/Div
Y pos.(Div): 0
Channel B
Scale: 5 V/Div
Y pos.(Div): 0
Trigger
Edge:
A
B
Ext
Level: 0
V

5)Finally implement the PID amplifier and show its performance in time domain for various input signal profiles.

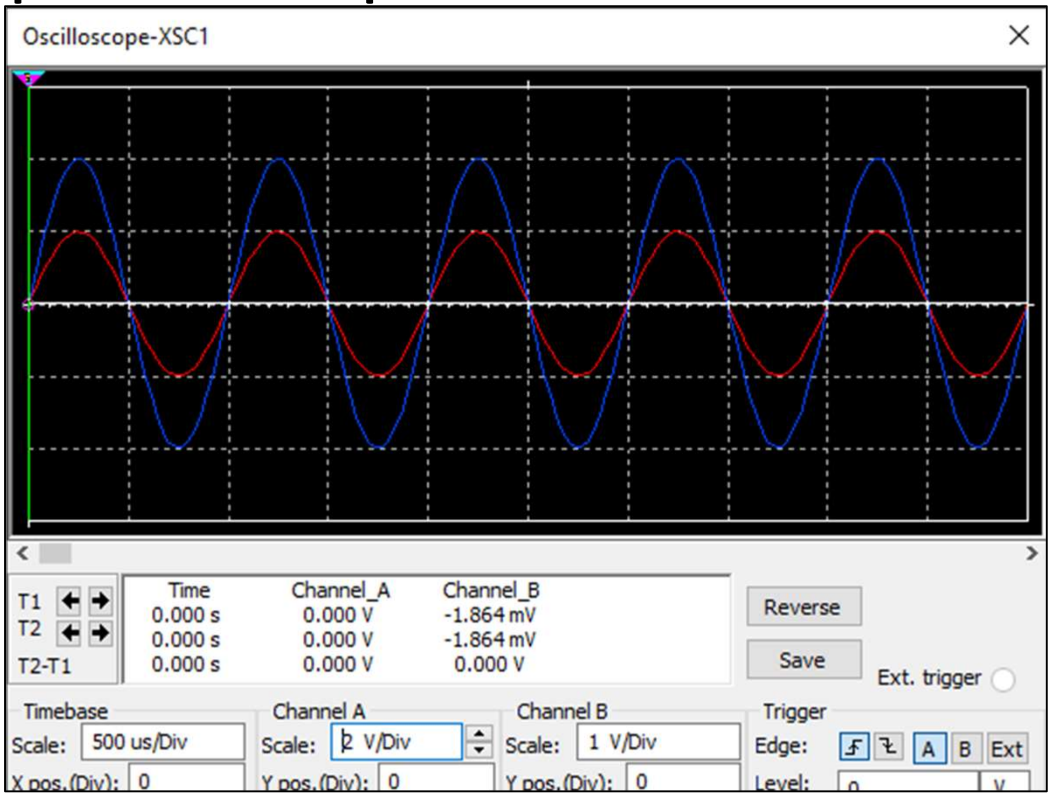
- PID Amplifier Circuit:



- PID Amplifier Input 1:



- PID Amplifier Output 1:

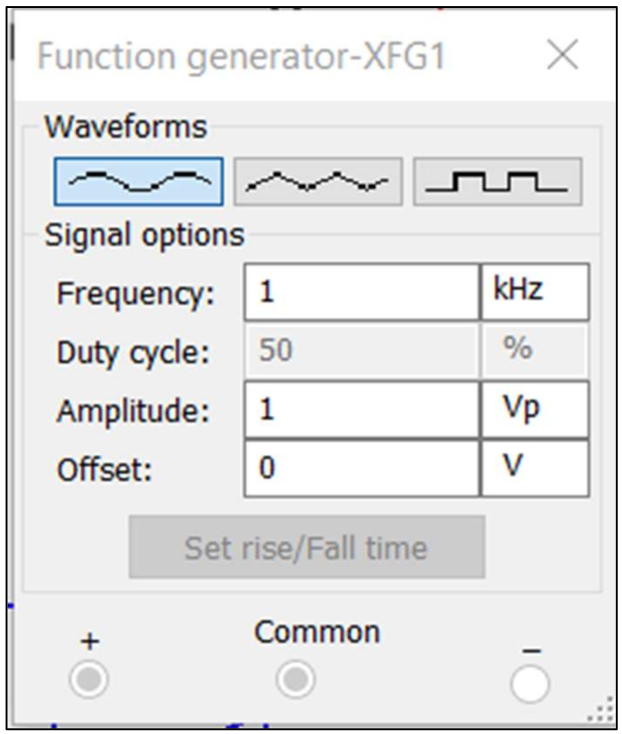


- Here Scales of the two plots have been changed as they are equal

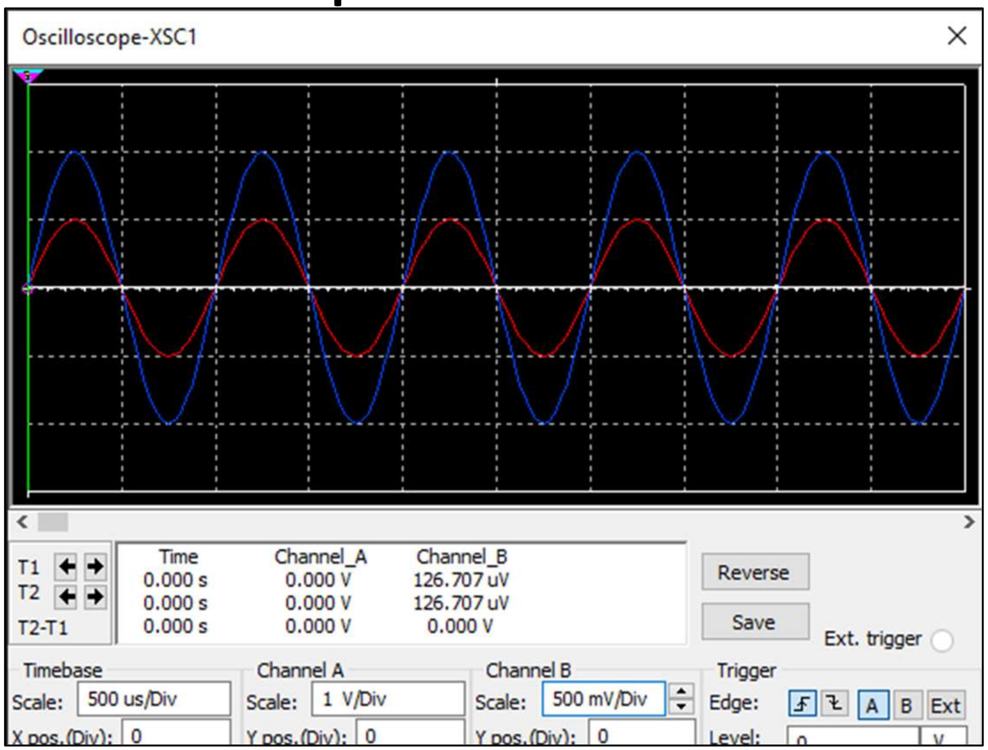
Explanation of Output

- Proportionality of sine function is sine
- Integral of sine function is –cosine
- Differentiation of sine function is cosine
- Hence when P, I, D of this input will be added, only sine will remain, giving the exact same output as the input

- PID Amplifier Input 2:



- PID Amplifier Output 2:



- Here Scales of the two plots have been changed as they are equal

Thank You