MP309

Experiment 6

Study of Differentiator and Integrator using Operational Amplifier

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Part 1:- Integrator using Opamp



Figure 1: Oscilloscope



Figure 2: Oscilloscope Probe

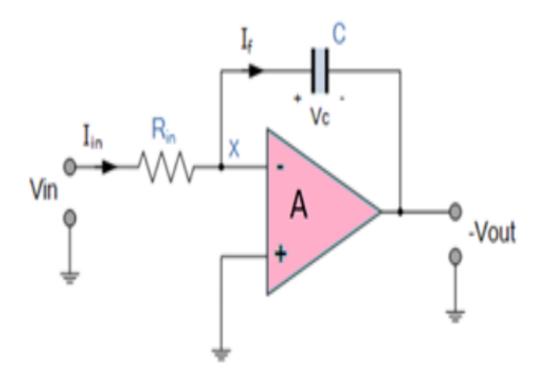


Figure 3: Integrator Circuit

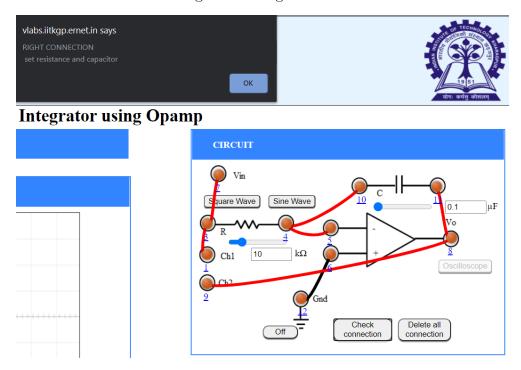


Figure 4: Integrator Circuit Connections

Initial Parameters :-

- Resistance(R) = 10 k Ω
- Capacitance(C) = 0.1 μ F

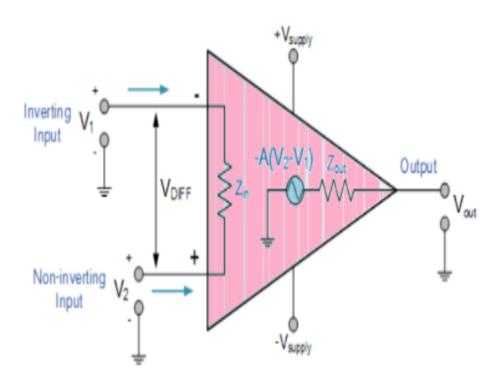


Figure 5: Operational Amplifier

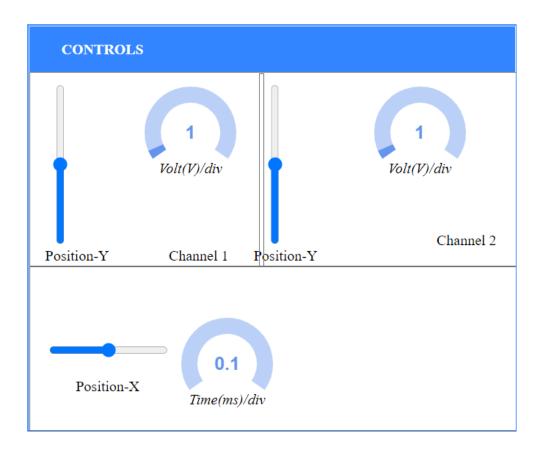


Figure 6: Controls

Oscilloscope

- * Channel 1(Input):
- * Channel 2(Output):

Figure 7: Oscilloscope Channel representation



Figure 8: Square Wave at Frequency = 1000

```
\begin{aligned} & \text{Frequency} = (\text{ 1 / Time Period }) \\ & \text{Time Period} = (\text{ 1 / frequency }) \\ & \text{Time Period} = (\text{ 1 / 1000 }) = 1 \\ & \text{msec} \\ & \text{Amplitude (Volt/div)} = 1 \\ & \text{V} \\ & \text{Time(ms)/div} = 0.1 \\ & \text{ms} \end{aligned}
```



Figure 9: Square Wave at Frequency = 2000

Frequency = (1 / Time Period) $\label{eq:Time Period}$ Time Period = (1 / frequency) $\label{eq:Time Period}$ Time Period = (1 / 2000) = 0.5msec $\label{eq:Amplitude}$ Amplitude (Volt/div) = 1 V



Figure 10: Square Wave at Frequency = 3000

```
\label{eq:frequency} \begin{split} & \text{Frequency} = (\ 1\ /\ \text{Time Period}\ ) \\ & \text{Time Period} = (\ 1\ /\ \text{frequency}\ ) \\ & \text{Time Period} = (\ 1\ /\ 3000\ ) = 0.333\text{msec} \\ & \text{Amplitude (Volt/div)} = 1\ \text{V} \\ & \text{Time(ms)/div} = 0.1\ \text{ms} \end{split}
```



Figure 11: Square Wave at Frequency = 4000

```
Frequency = ( 1 / Time Period ) 
Time Period = ( 1 / frequency ) 
Time Period = ( 1 / 4000 ) = 0.25msec 
Amplitude (Volt/div) = 1 V 
Time(ms)/div = 0.1 ms
```



Figure 12: Square Wave at Frequency = 5000

```
\begin{aligned} & \text{Frequency} = (\text{ 1 / Time Period }) \\ & \text{Time Period} = (\text{ 1 / frequency }) \\ & \text{Time Period} = (\text{ 1 / 5000 }) = 0.2 \\ & \text{msec} \\ & \text{Amplitude (Volt/div)} = 1 \text{ V} \\ & \text{Time(ms)/div} = 0.1 \text{ ms} \end{aligned}
```

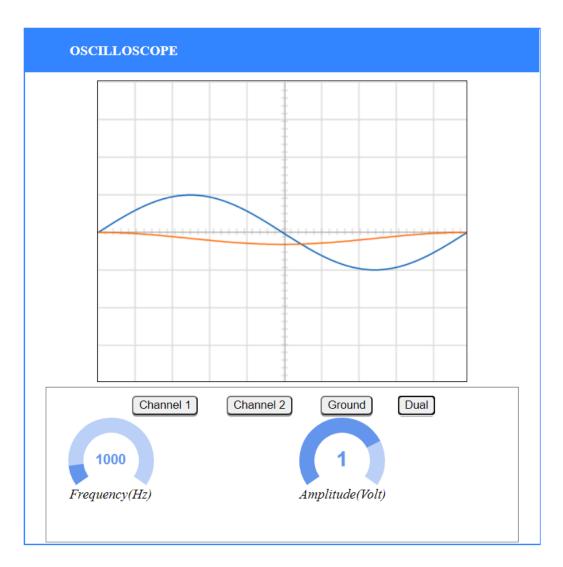


Figure 13: Sine Wave at Frequency = 1000

```
\begin{aligned} & \text{Frequency} = (\text{ 1 / Time Period }) \\ & \text{Time Period} = (\text{ 1 / frequency }) \\ & \text{Time Period} = (\text{ 1 / 1000 }) = 1 \\ & \text{msec} \\ & \text{Amplitude (Volt/div)} = 1 \\ & \text{V} \\ & \text{Time(ms)/div} = 0.1 \\ & \text{ms} \end{aligned}
```

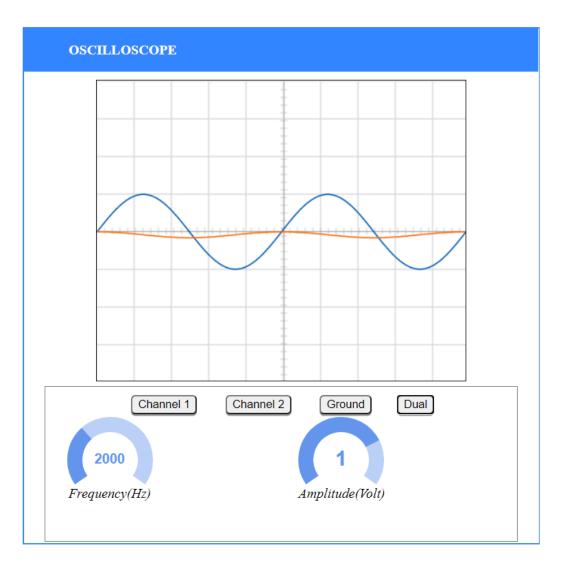


Figure 14: Sine Wave at Frequency = 2000

```
Frequency = ( 1 / Time Period ) 
Time Period = ( 1 / frequency ) 
Time Period = ( 1 / 2000 ) = 0.5msec 
Amplitude (Volt/div) = 1 V 
Time(ms)/div = 0.1 ms
```

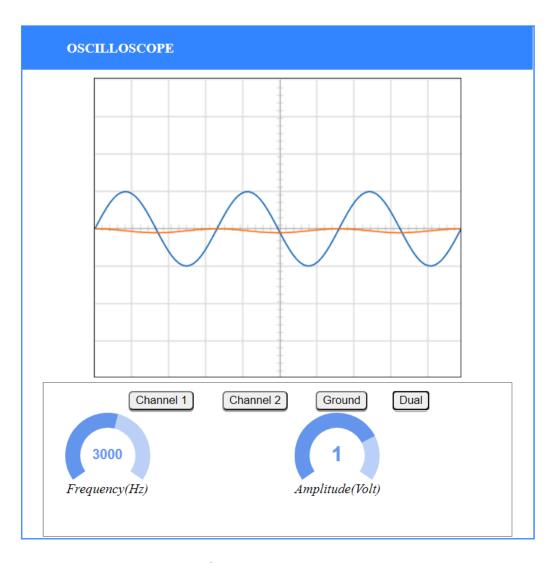


Figure 15: Sine Wave at Frequency = 3000

```
\begin{aligned} & \text{Frequency} = (\text{ 1 / Time Period }) \\ & \text{Time Period} = (\text{ 1 / frequency }) \\ & \text{Time Period} = (\text{ 1 / 3000 }) = 0.333 \\ & \text{msec} \\ & \text{Amplitude (Volt/div)} = 1 \text{ V} \\ & \text{Time(ms)/div} = 0.1 \text{ ms} \end{aligned}
```

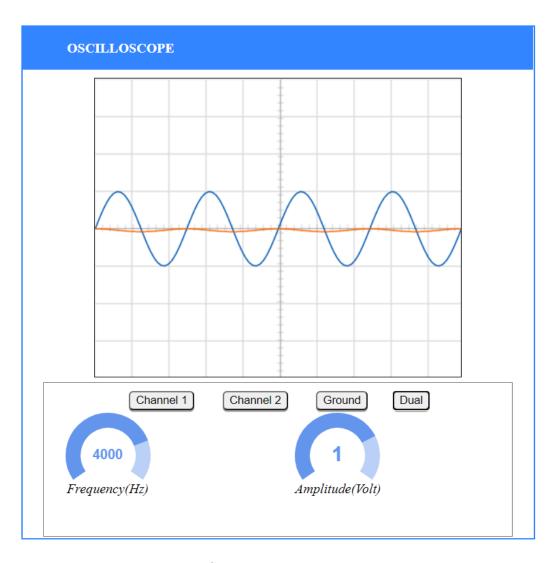


Figure 16: Sine Wave at Frequency = 4000

```
Frequency = ( 1 / Time Period ) 
Time Period = ( 1 / frequency ) 
Time Period = ( 1 / 4000 ) = 0.25msec 
Amplitude (Volt/div) = 1 V 
Time(ms)/div = 0.1 ms
```

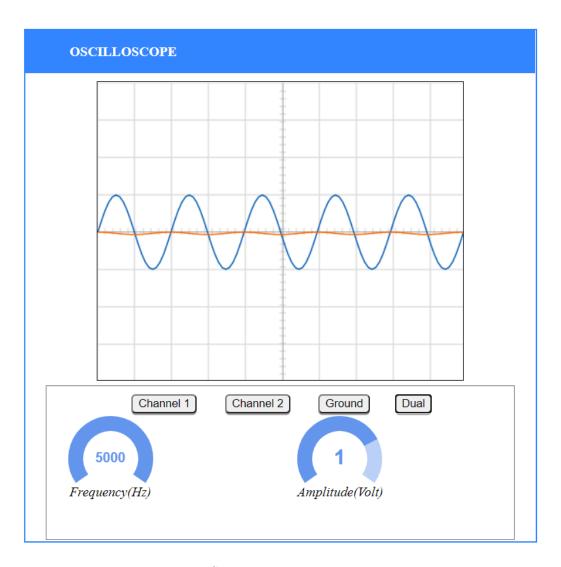


Figure 17: Sine Wave at Frequency = 5000

```
\begin{aligned} & \text{Frequency} = (\text{ 1 / Time Period }) \\ & \text{Time Period} = (\text{ 1 / frequency }) \\ & \text{Time Period} = (\text{ 1 / 5000 }) = 0.2 \\ & \text{msec} \\ & \text{Amplitude (Volt/div)} = 1 \text{ V} \\ & \text{Time(ms)/div} = 0.1 \text{ ms} \end{aligned}
```

Part 2 :- Differentiator using Opamp

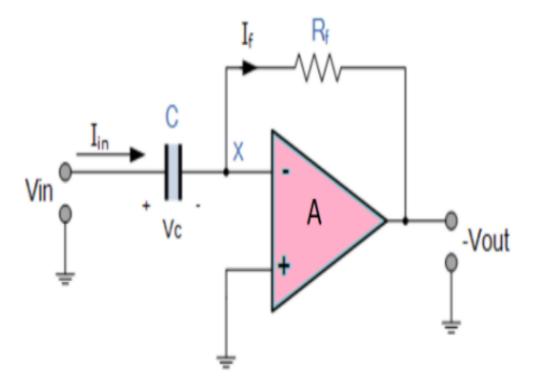


Figure 1: Differentiator Circuit

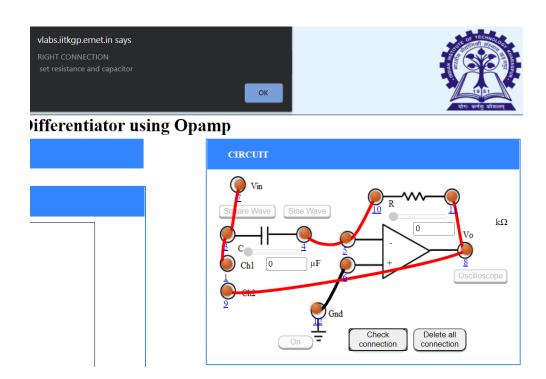


Figure 2: Differentiator Circuit Connections

Initial Parameters :-

- Resistance(R) = $1 \text{ k}\Omega$
- Capacitance(C) = 0.1 μ F

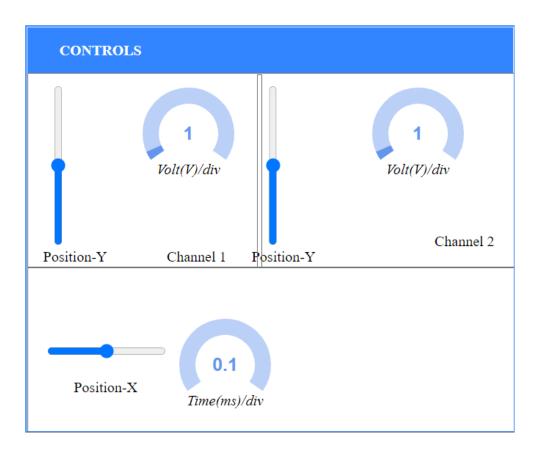


Figure 3: Controls

Oscilloscope

- * Channel 1(Input):
- * Channel 2(Output):

Figure 4: Oscilloscope Channel representation



Figure 5: Square Wave at Frequency = 1000

 $\label{eq:Frequency} \text{Frequency} = \left(\text{ 1 / Time Period } \right)$

 ${\rm Time\ Period} = (\ 1\ /\ {\rm frequency}\)$

Time Period = (1 / 1000) = 1msec

 $Amplitude \; (Volt/div) = 1 \; V$



Figure 6: Square Wave at Frequency = 2000

 $\label{eq:Frequency} \text{Frequency} = \left(\begin{array}{c} 1 \end{array} \middle / \text{ Time Period} \right. \right)$

 $\label{eq:time_period} \mbox{Time Period} = (\ 1\ /\ \mbox{frequency}\)$

Time Period = (1 / 2000) = 0.5msec

 $Amplitude \; (Volt/div) = 1 \; V$



Figure 7: Square Wave at Frequency = 3000

```
\label{eq:frequency} \begin{split} &\text{Frequency} = (\ 1\ /\ \text{Time Period}\ ) \\ &\text{Time Period} = (\ 1\ /\ \text{frequency}\ ) \\ &\text{Time Period} = (\ 1\ /\ 3000\ ) = 0.333\text{msec} \\ &\text{Amplitude (Volt/div)} = 1\ \text{V} \\ &\text{Time(ms)/div} = 0.1\ \text{ms} \end{split}
```



Figure 8: Square Wave at Frequency = 4000

```
\begin{aligned} & \text{Frequency} = (\text{ 1 / Time Period }) \\ & \text{Time Period} = (\text{ 1 / frequency }) \\ & \text{Time Period} = (\text{ 1 / 4000 }) = 0.25 \\ & \text{msec} \end{aligned} & \text{Amplitude (Volt/div)} = 1 \text{ V} & \text{Time(ms)/div} = 0.1 \text{ ms}
```

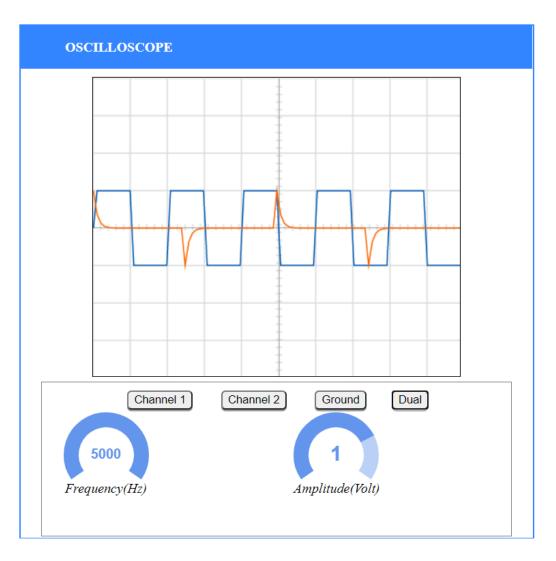


Figure 9: Square Wave at Frequency = 5000

 $\begin{aligned} & \text{Frequency} = (\ 1\ /\ \text{Time Period}\) \\ & \text{Time Period} = (\ 1\ /\ \text{frequency}\) \end{aligned}$

Time Period = (1 / 5000) = 0.2msec

 $Amplitude \; (Volt/div) = 1 \; V$

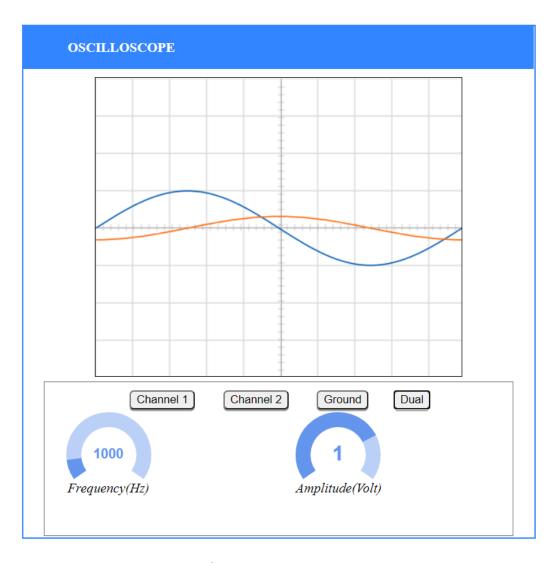


Figure 10: Sine Wave at Frequency = 1000

 $\begin{aligned} & \text{Frequency} = (\text{ 1 / Time Period }) \\ & \text{Time Period} = (\text{ 1 / frequency }) \\ & \text{Time Period} = (\text{ 1 / 1000 }) = 1 \\ & \text{msec} \\ & \text{Amplitude (Volt/div)} = 1 \\ & \text{V} \\ & \text{Time(ms)/div} = 0.1 \\ & \text{ms} \end{aligned}$

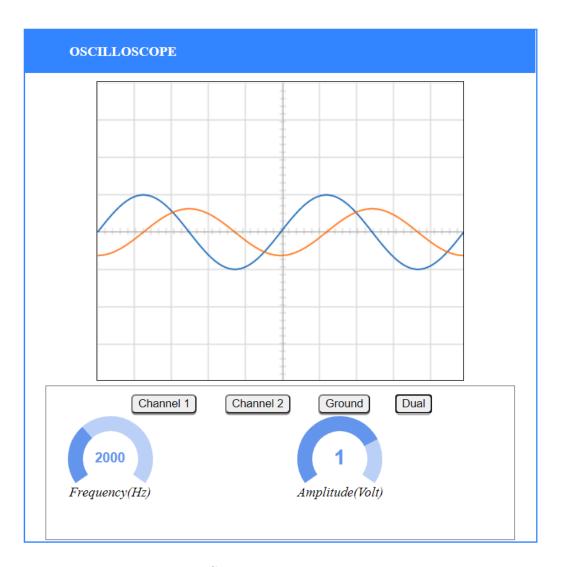


Figure 11: Sine Wave at Frequency = 2000

```
\begin{aligned} & \text{Frequency} = (\text{ 1 / Time Period }) \\ & \text{Time Period} = (\text{ 1 / frequency }) \\ & \text{Time Period} = (\text{ 1 / 2000 }) = 0.5 \\ & \text{msec} \\ & \text{Amplitude (Volt/div)} = 1 \text{ V} \\ & \text{Time(ms)/div} = 0.1 \text{ ms} \end{aligned}
```

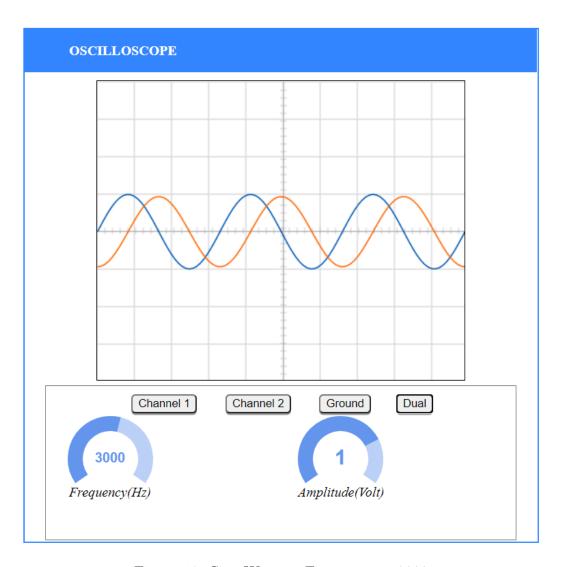


Figure 12: Sine Wave at Frequency = 3000

```
Frequency = ( 1 / Time Period ) 
Time Period = ( 1 / frequency ) 
Time Period = ( 1 / 3000 ) = 0.333msec 
Amplitude (Volt/div) = 1 V 
Time(ms)/div = 0.1 ms
```

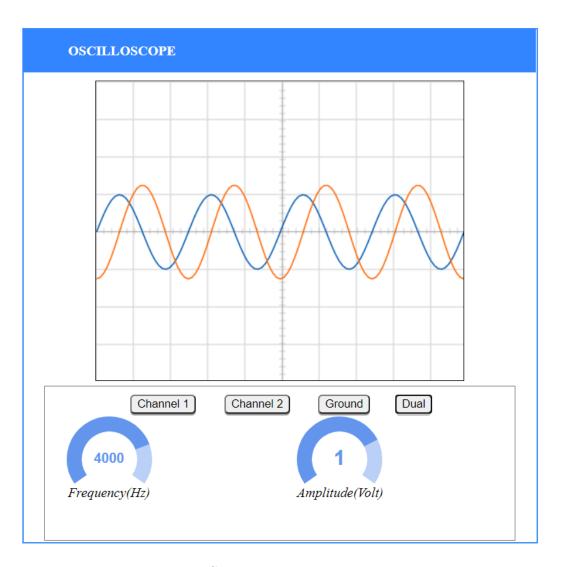


Figure 13: Sine Wave at Frequency = 4000

Frequency = (1 / Time Period) Time Period = (1 / frequency) Time Period = (1 / 4000) = 0.25msec Amplitude (Volt/div) = 1 V Time(ms)/div = 0.1 ms

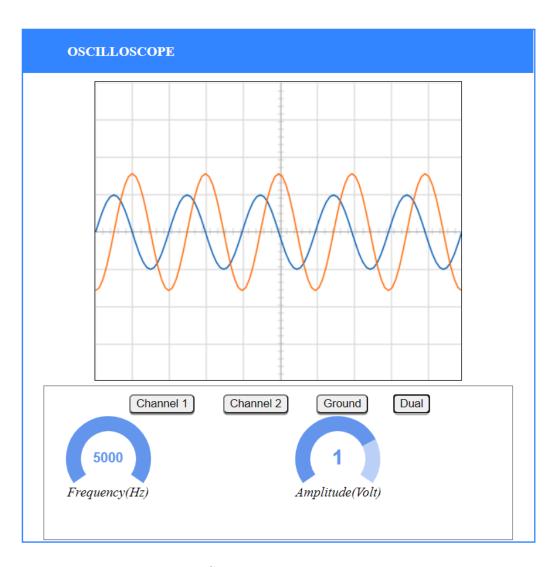


Figure 14: Sine Wave at Frequency = 5000

 $\begin{aligned} & \text{Frequency} = (\text{ 1 / Time Period }) \\ & \text{Time Period} = (\text{ 1 / frequency }) \\ & \text{Time Period} = (\text{ 1 / 5000 }) = 0.2 \\ & \text{msec} \\ & \text{Amplitude (Volt/div)} = 1 \text{ V} \\ & \text{Time(ms)/div} = 0.1 \text{ ms} \end{aligned}$