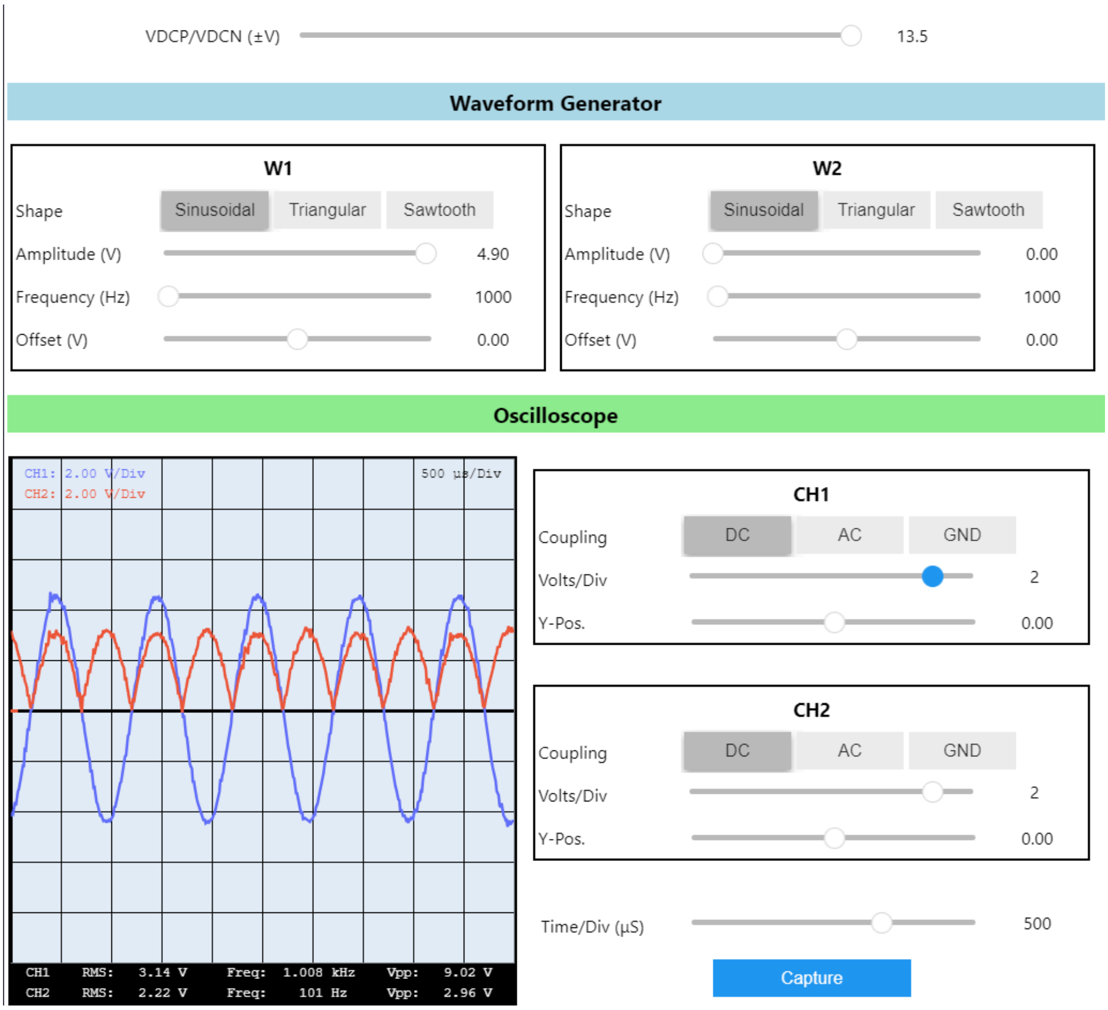
Lab 7

Objectives

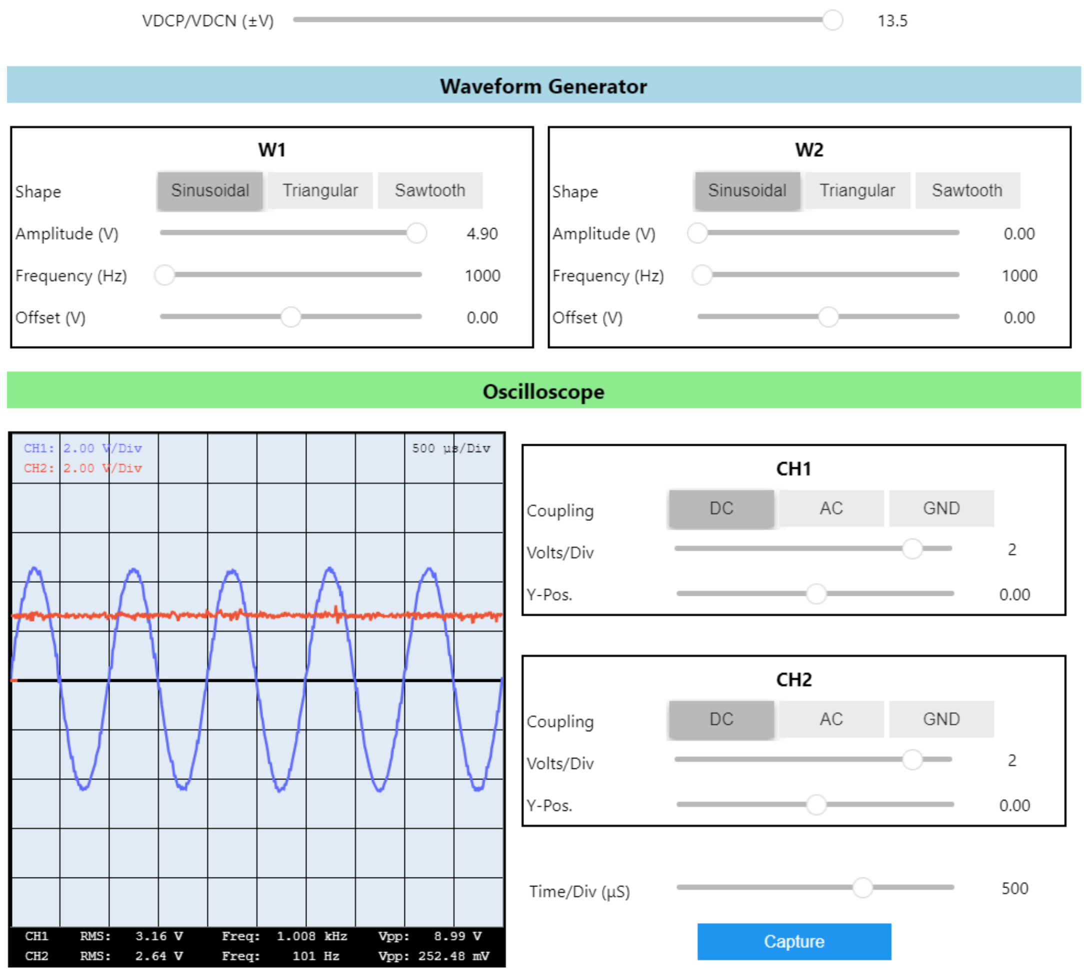
To construct and study the function of the volume unit meter (VU Meter).

Vout1-pp

Vout2-pp


VDCP/VDCN (±V) 13.5
Waveform Generator
W1
Shape Sinusoidal Triangular Sawtooth
Amplitude (V) 4.90
Frequency (Hz) 1000
Offset (V) 0.00
W2
Shape Sinusoidal Triangular Sawtooth
Amplitude (V) 0.00
Frequency (Hz) 1000
Offset (V) 0.00
Oscilloscope
CH1: 2.00 V/Div
CH2: 2.00 V/Div
500 µs/Div
CH1 RMS: 3.14 V Freq: 1.008 kHz Vpp: 9.02 V
CH2 RMS: 2.22 V Freq: 101 Hz Vpp: 2.96 V
CH1
Coupling DC AC GND
Volts/Div 2
Y-Pos. 0.00
CH2
Coupling DC AC GND
Volts/Div 2
Y-Pos. 0.00
Time/Div (µS) 500
Capture

Vout3-pp (RMS)



Amp(V)	Vin-pp(V)	Vo1-pp(V)	Vo2-pp(V)	Vo3-RMS(V)
4.9	8.98	3.84	3.1	2.64
3.8	7.02	3.2	2.34	1.96
3.9	7.18	3.28	2.43	2.02
2.8	5.2	2.56	1.74	1.36
2.9	5.26	2.5	1.76	1.32
1.8	3.46	1.9	1.2	753.9m
1.9	3.54	1.88	1.21	815.69m
0.8	1.56	1.22	643.63m	246.82m
0.9	1.76	1.27	655.72m	294.90m

VU Meter gain measurement

VU Meter gain characterization

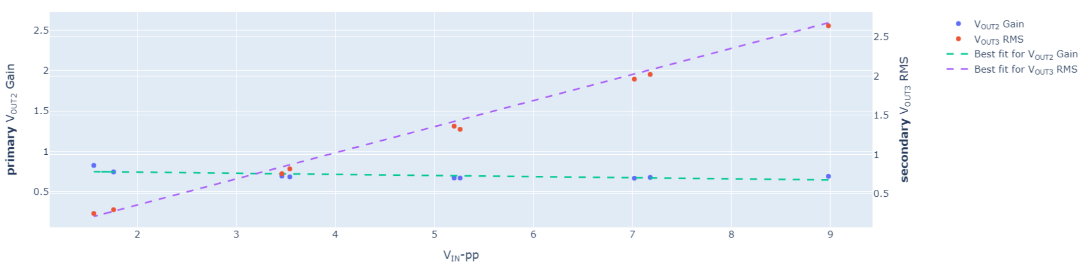
In [ ]:
```
import numpy as np
import plotly.graph_objs as go
from plotly.subplots import make_subplots
```

```
vpp_IN = np.array([8.98,7.02,7.18,5.2,5.26,3.46,3.54,1.56,1.76])
v_OUT_01 = np.array([3.84,3.2,3.28,2.56,2.5,1.9,1.88,1.22,1.27])
v_OUT_02 = np.array([3.1,2.34,2.43,1.74,1.76,1.2,1.21,0.64363,0.65572])
vrms_OUT_03 = np.array([2.64,1.96,2.02,1.36,1.32,0.7539,0.81569,0.24682,0.2949])

gain_v_OUT_02 = (2*v_OUT_02)/vpp_IN

fig = go.Figure()
#fig.update_xaxes(type='log')
fig = make_subplots(specs=[[{"secondary_y": True}]])
fig.add_trace(go.Scatter(x=vpp_IN, y=gain_v_OUT_02, mode='markers', name='V<sub>
fig.add_trace(go.Scatter(x=vpp_IN, y=vrms_OUT_03, mode='markers', name='V<sub>OU
fig.update_xaxes(title_text="V<sub>IN</sub>-pp")
fig.update_yaxes(title_text="<b>primary</b> V<sub>OUT2</sub> Gain", secondary_y=
fig.update_yaxes(title_text="<b>secondary</b> V<sub>OUT3</sub> RMS", secondary_y
#fig.update_layout(xaxis_title='V<sub>IN</sub>-pp', yaxis_title='V<sub>OUT3</sub

coef = np.polyfit(vpp_IN, gain_v_OUT_02, deg=1) # deg=1 for order 1 polynomial (
fit = coef[0]*vpp_IN + coef[1]
lab_temp = 25 # laboratory temperature
fig.add_trace(go.Scatter(x=vpp_IN, y=fit, mode='lines', line=dict(dash='dash'),
 name='Best fit for V<sub>OUT2</sub> Gain'))
coef = np.polyfit(vpp_IN, vrms_OUT_03, deg=1) # deg=1 for order 1 polynomial (li
fit = coef[0]*vpp_IN + coef[1]
lab_temp = 25 # laboratory temperature
fig.add_trace(go.Scatter(x=vpp_IN, y=fit, mode='lines', line=dict(dash='dash'),
 name='Best fit for V<sub>OUT3</sub> RMS'))
```



In [ ]:
```
total_gain_out2 = 0.0
for i in range(len(gain_v_OUT_02)):
    total_gain_out2 += gain_v_OUT_02[i]

print("Average Gain (Vout2-pp)", total_gain_out2/9.0 )
```

```
Average Gain (Vout2-pp) 0.7022180900271009
```

The average gain from my measured values is around 0.702. This is very close to the theoretical gain value of 0.7

The function of a VU meter can be met as the the plot of Vout3/Vin produces a linear best fit line. Which indicates that the Vout3 follows Vin linearly.

Open-Ended Questions

1. What does the two diodes do in the VU Meter? Explain using the waveforms observed at VOUT1 and VOUT2.

ANS: The first diode acts as a full-wave rectifier. The second diode acts as a peak detector. Together with the capacitor, it detects and holds the peak voltage levels of the output.

2. What happens to VOUT3 if there is a DC offset at VIN?

ANS: VOUT3 will produce an inaccurate reading as the DC offset from the Vin will be amplified and cause the Vout3 to change. Too high of a DC offset might cause damage to the amplifier.

3. At what volume, i.e., PA output amplitude, does the VU Meter fails to function?

ANS: From the voltage source of the op-amp, a volume that will cause the Op-amp to saturate to 13.5V will cause the Vu meter to fail as it is limited by the voltage source of the op amp.