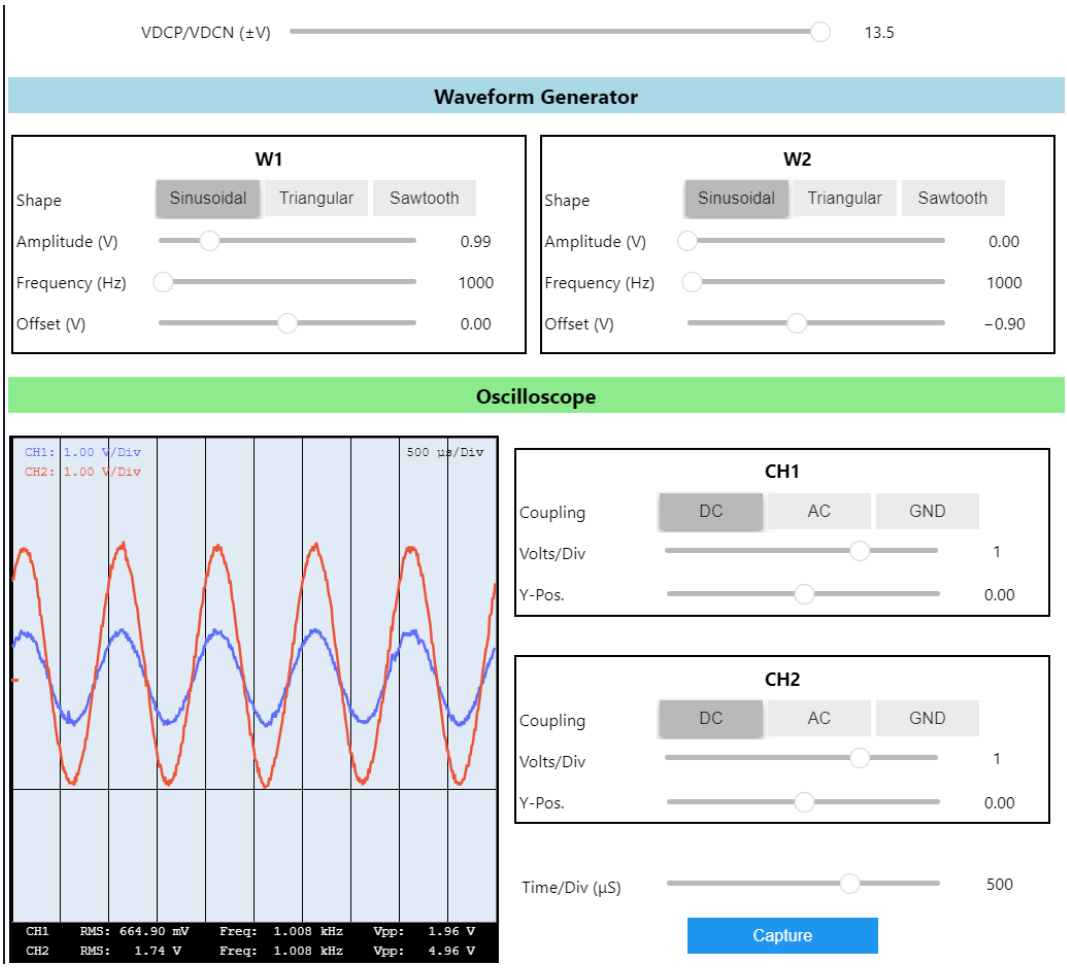
Lab 5

Objective

To construct and study the transfer characteristic of the voltage-controlled amplifier (VCA) subsystem.

Capture Example



In [ ]:
```
#communication channel setup
import serial
import serial.tools.list_ports
import numpy as np
import plotly.graph_objs as go

VID = 61525
PID = 38912

device = None

ports = serial.tools.list_ports.comports()
for p in ports:
    if p.vid == VID and p.pid == PID:
        try:
```

```
            device = serial.Serial(p.device)
        except serial.SerialException:
            print('Reconnect the controller unit.')

if device is None:
    raise Exception('No suitable device detected.')
```

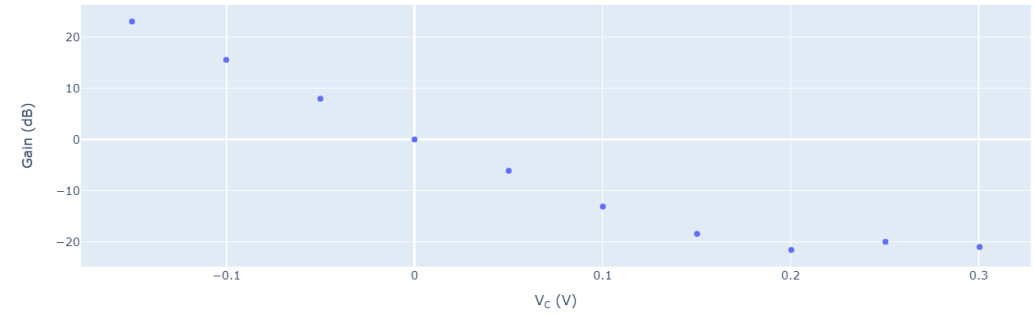
VCA gain characterization

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

v_a = np.array([5.4, 4.5, 3.6, 2.7, 1.8, 0.9, 0, -0.9, -1.8, -2.7])
v_IN = np.array([5.7,5.48,5.5,5.5,3.61,3.63,3.62,1.96,1.8,1.7])
v_OUT = np.array([0.51,0.55,0.46,0.66,0.8,1.8,3.63,4.91,10.81,24.18])

v_C = 3.3/(56 + 3.3)*v_a # Eq. (5.2)
gain = 20*np.log10(v_OUT/v_IN) # Eq. (5.3)

fig = go.Figure()
fig.add_trace(go.Scatter(x=v_C, y=gain, mode='markers', name='Measured gain'))
fig.update_layout(xaxis_title='V<sub>C</sub> (V)', yaxis_title='Gain (dB)')
```



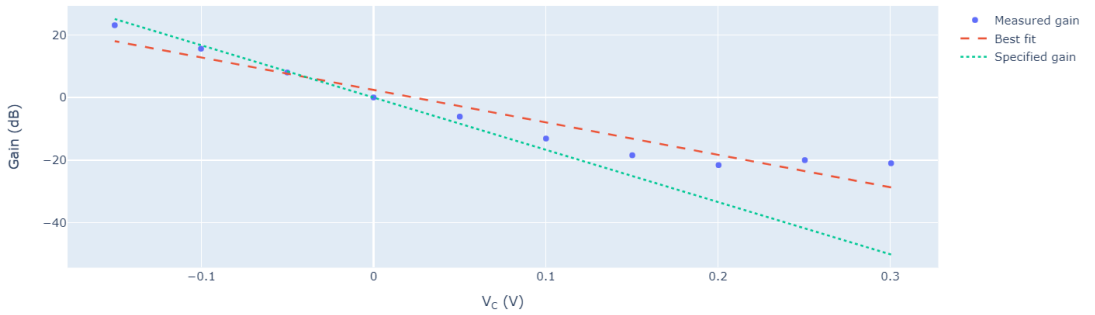
In [ ]:
```
coef = np.polyfit(v_C, gain, deg=1) # deg=1 for order 1 polynomial (linear)
fit = coef[0]*v_C + coef[1]

lab_temp = 25 # laboratory temperature
gain_spec = -v_C/(0.006*(1 + 0.0033*(lab_temp - 25))) # Eq. (5.1)

fig.add_trace(go.Scatter(x=v_C, y=fit, mode='lines', line=dict(dash='dash'),
  name='Best fit'))
fig.add_trace(go.Scatter(x=v_C, y=gain_spec, mode='lines', line=dict(dash='dot')
  name='Specified gain'))

print('m = ' + str(coef[0]))
print('measured gain sensitivity =' + str(1/coef[0]))
```

```
m = -103.4584811782203
measured gain sensitivity =-0.00966571313063618
```



Measured gain sensitivity = ~ -9mV/dB, which is larger in magnitutde than the specified gain sensitivity

Applying small signal amplitude results in low Vin which also results in high Vout

High signal amplitude with high VCA gains will results saturation which in theory let Vout = +13.5V / -13.5V

Open-Ended Questions

A VCA is a processor that can change the amplitude of a signal in response to a control voltage applied to its amplitude modulation control input.