Physics 111A
Lab 10

Problem R10.1:

a) With ramp interpolation, the sampled wave is a triangle wave. It's somewhat reasonable When the phase is set to 45° the sampled wave is now a trapezoidal wave instead of triangular. This wave is more reasonable.
With a sample rate of 4.05 the ramp interpolation is closer to the sine wave by showing some curvature.
With an expanded time axis it is harder to account for the qualitative differences.

b) The sampled wave is a better facsimile of the original wave when done with flat interpolation. It is an almost perfect reconstruction, only difference being a small phase shift
When phase is shifted by 45°, it is a perfect reconstruction
When the sample frequency is set to 4.05, the sampled wave is a worse facsimile since on occasion it will sample a point during the rise or falling portion, creating a step instead a square

c) The sampling rate is of comparable value to the original waveforms frequency resulting in an inadequate number of sample points to reconstruct the wave. Sine wave is constantly changing so a lot of information can be lost between sample points.

d) The square wave is easier to reconstruct at lower sample rates since its not changing constantly so as long a the sample rate is double the frequency of the original wave, there will be adequate enough data to create an accurate facsimile

e) For a sine wave, sample rate of 6Hz produces a reasonable facsimile using ramp interpolation.
2Hz is good for a square wave using flat interpolation.
They are different due to information lost between samples. Due to sine wave changing there is lost data points while square waves are constant so you can get away with less sample points.

f) No, a square and sine wave would both appear like triangle waves at the Nyquist frequency

g) Two-Tone - 5 Hz
AM - 6 Hz
FM - 4 Hz

h) You can use lower sample rates to recreate an accurate sine wave, but the amplitude would be incorrect.

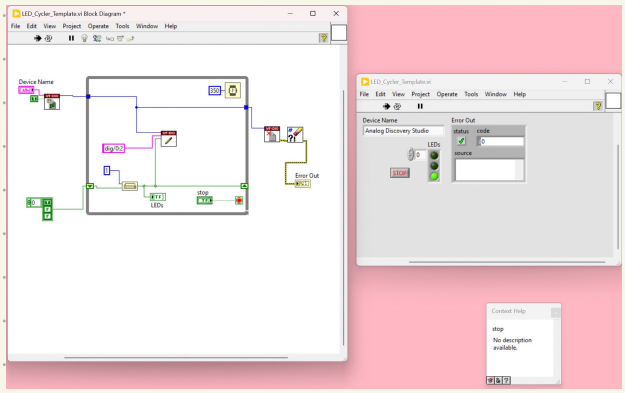
i) Yes, the filter greatly improves the accuracy of the sampled wave.

j) No interpolation method helps produce an accurate facsimile of the original wave with a realistic low pass.
With an ideal low-pass filter, comb interpolation produces the best wave.
The lowest we can go is 2.003 Hz for the sampling frequency.

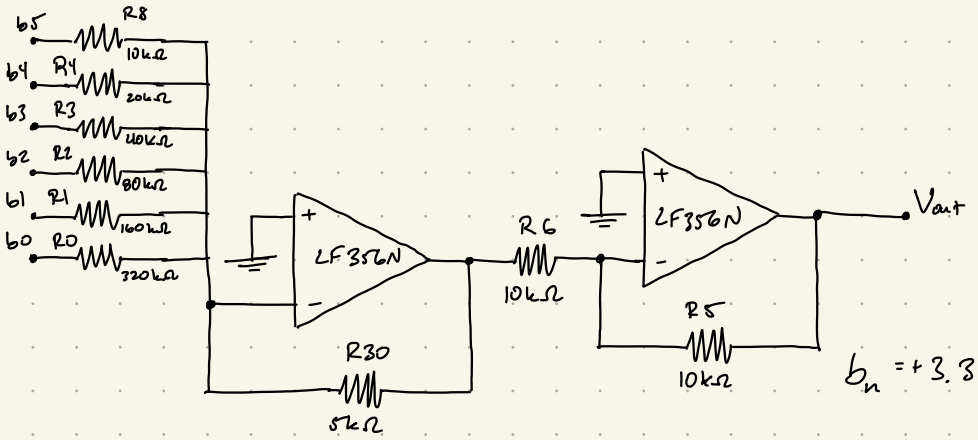
k) The ideal and realistic low-pass filters both produce poor facsimiles of the original wave.

2) Two-tone: 2.003Hz, AM: 2.0Hz, FM: 1.9Hz. A square wave is partially composed of high frequency waves which end up filtered out.

Problem R10.2:



Problem R10.3:



a) b_0 corresponds to the lowest order bit

R8 - 1 10kΩ
R4 - 2 10kΩ
R3 - 4 10kΩ
R2 - 1 75kΩ, 1 3kΩ, 1 2kΩ
R1 - 1 150kΩ, 1 10kΩ
R0 - 1 220kΩ, 1 150kΩ

$b_n = +3.3V$, $I_{total} = \sum_{i=0}^{5} \left(\frac{1}{2}\right)^i \frac{3.3V}{10k\Omega} = 6.497 \times 10^{-4} A$

$-V_{out} = I_{tot}(5k\Omega) = 3.248V \Rightarrow V_{out} = 3.248V$

b) The DAC works for upto requested voltages of 3.25V. That is its limit.

c) We made the subvis.

d) The WriteDACandReadADC.vi still works.

Problem R10.4:

a) The program runs as expected

b) Turning on b_5 causes the biggest steps in the data. This bit change were the most likely to cause trouble since it is the most significant bit that can be represent and supplies the greatest current to the summer. Yes, the steps are compatible with the accuracy of the resistors.

c)

b_n	V_{out} (V)
0	3.29
1	3.29
2	3.29
3	3.28
4	3.26
5	3.21

The offset for the higher bits is greater due to them having much lower input impedence, with b_5 being much less and resulting in a greater offset.

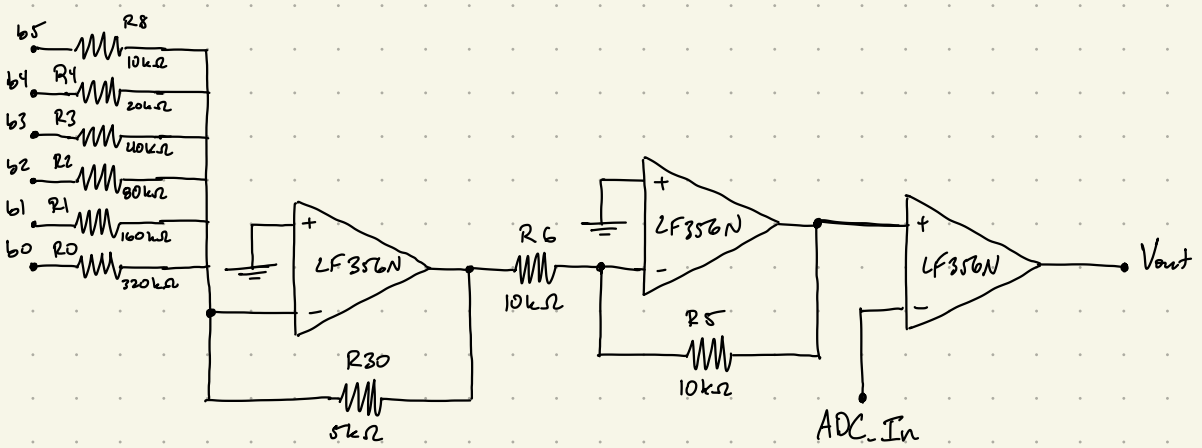
Problem R10.5:

a) We recreated Calculate Residuals.vi

b) We substituted our subvis into Plot Residual Scan.vi

c) Plot Residual Scan.vi works the same as it did with the original subvis.

Problem R10.6:



a) The comparator was built and integrated into the DAC circuit.

b) The ADC.vi works and correctly gives the necessary outputs.

c)

Target Voltage (V)	Final ADC Voltage (V)
0.1	0
0.5	0.413
1.0	0.929
1.2	1.135
1.5	1.444
2.0	1.960
2.3	2.270
2.5	2.476
3	2.992
3.25	3.198

Problem R10.7: