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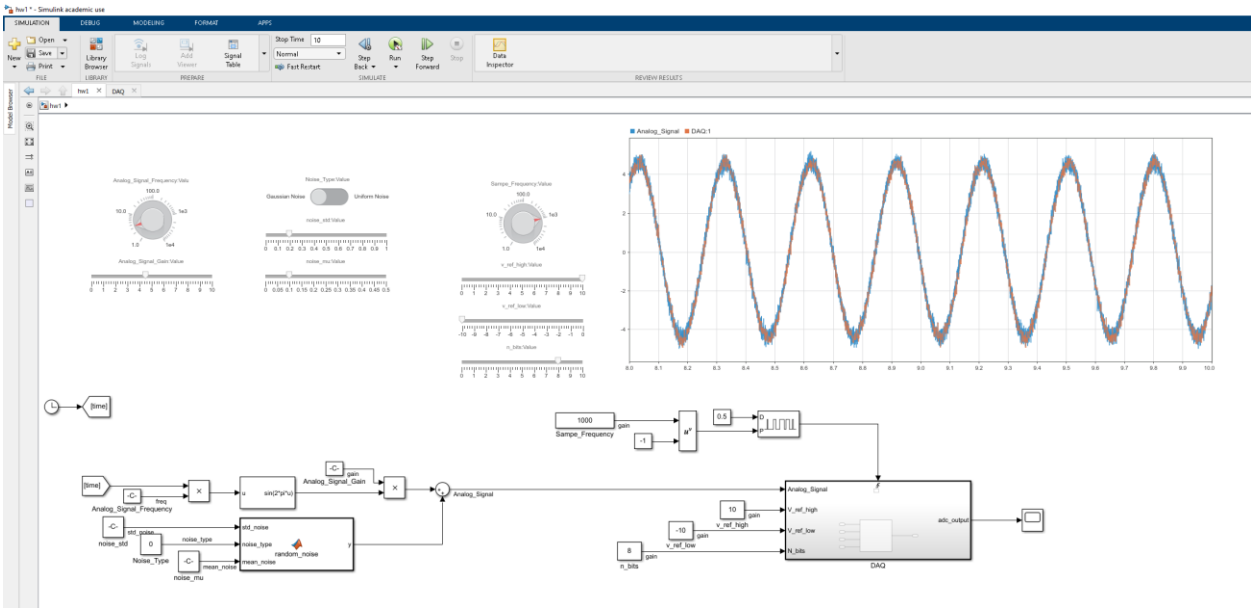
HW 1

Problem 1

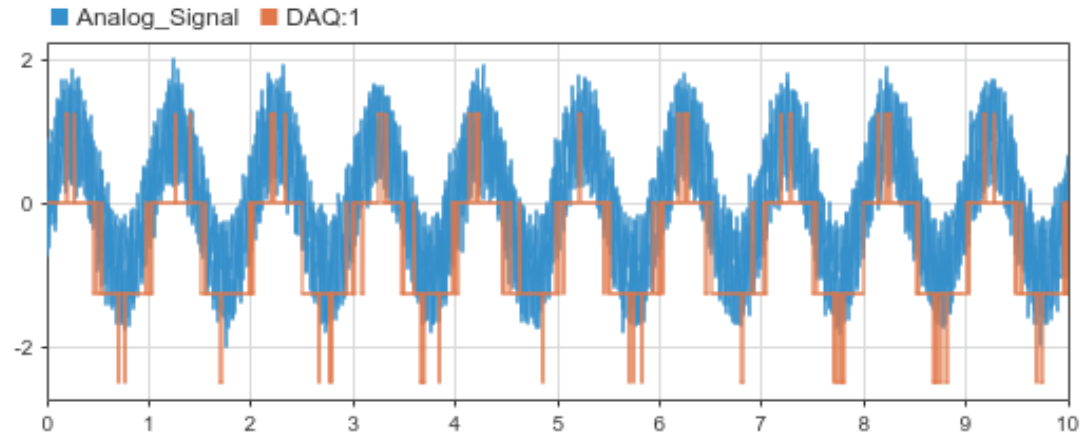
DAQ Code:

```
function y = daq(v_ref_high, v_ref_low, n_bits, signal_v)
v_ref_high = v_ref_high  - v_ref_low;
resolution = 2^n_bits;
delta = v_ref_high / resolution;
binary = zeros(resolution, 1);
signal_v = signal_v - v_ref_low;
for i=1:resolution
    comparator = v_ref_high - (i - 1) * delta;
    bit = signal_v >= comparator;
    binary(i) = bit * comparator;
    if bit
        signal_v = signal_v - comparator;
    end
end
y = sum(binary) + v_ref_low;
```

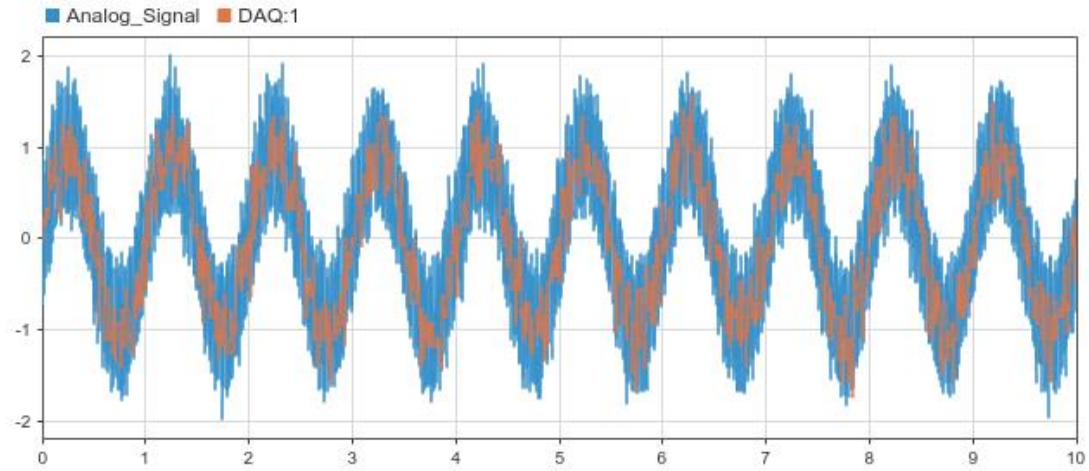
Simulink Model:



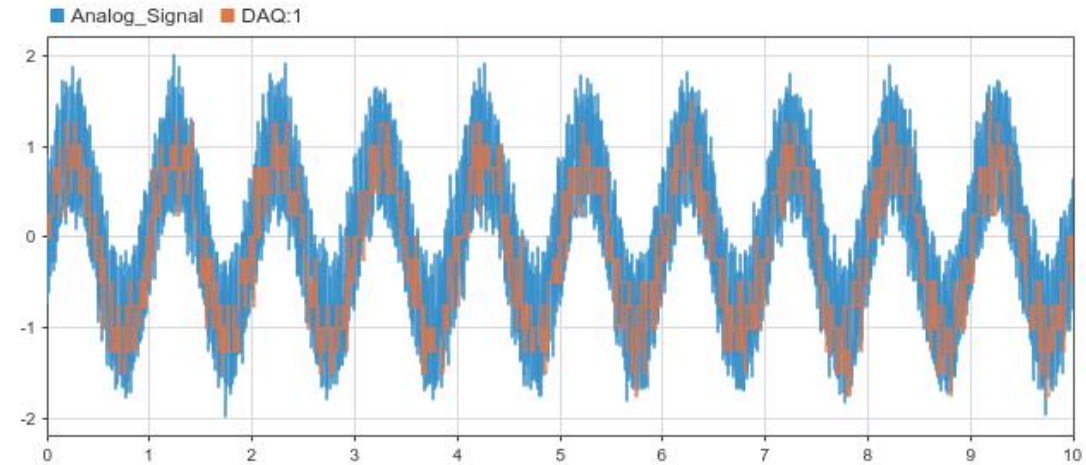
4 Bit, -10V to 10V @100Hz Sampling Frequency



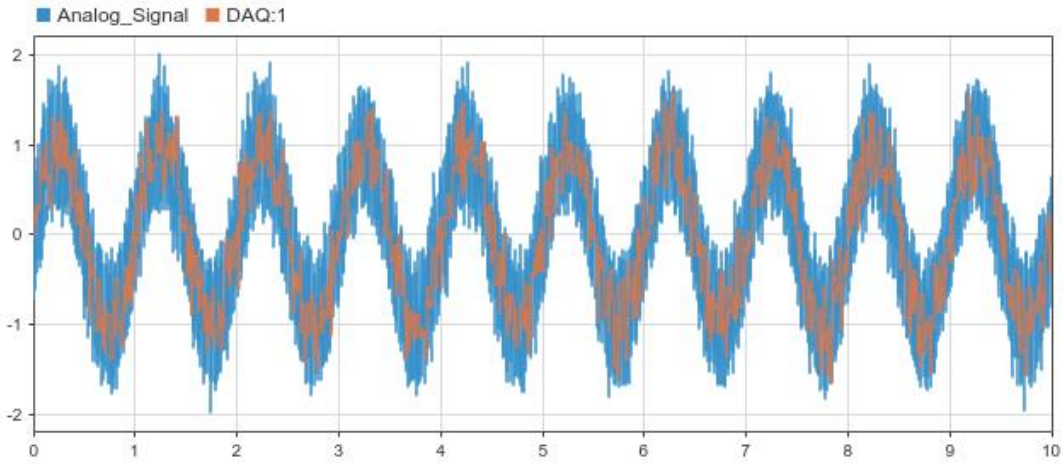
8 Bit, -10V to10V @100Hz Sampling Frequency



4 Bit, -2V to 2V @100Hz Sampling Frequency



8 Bit, -2V to 2V @100Hz Sampling Frequency

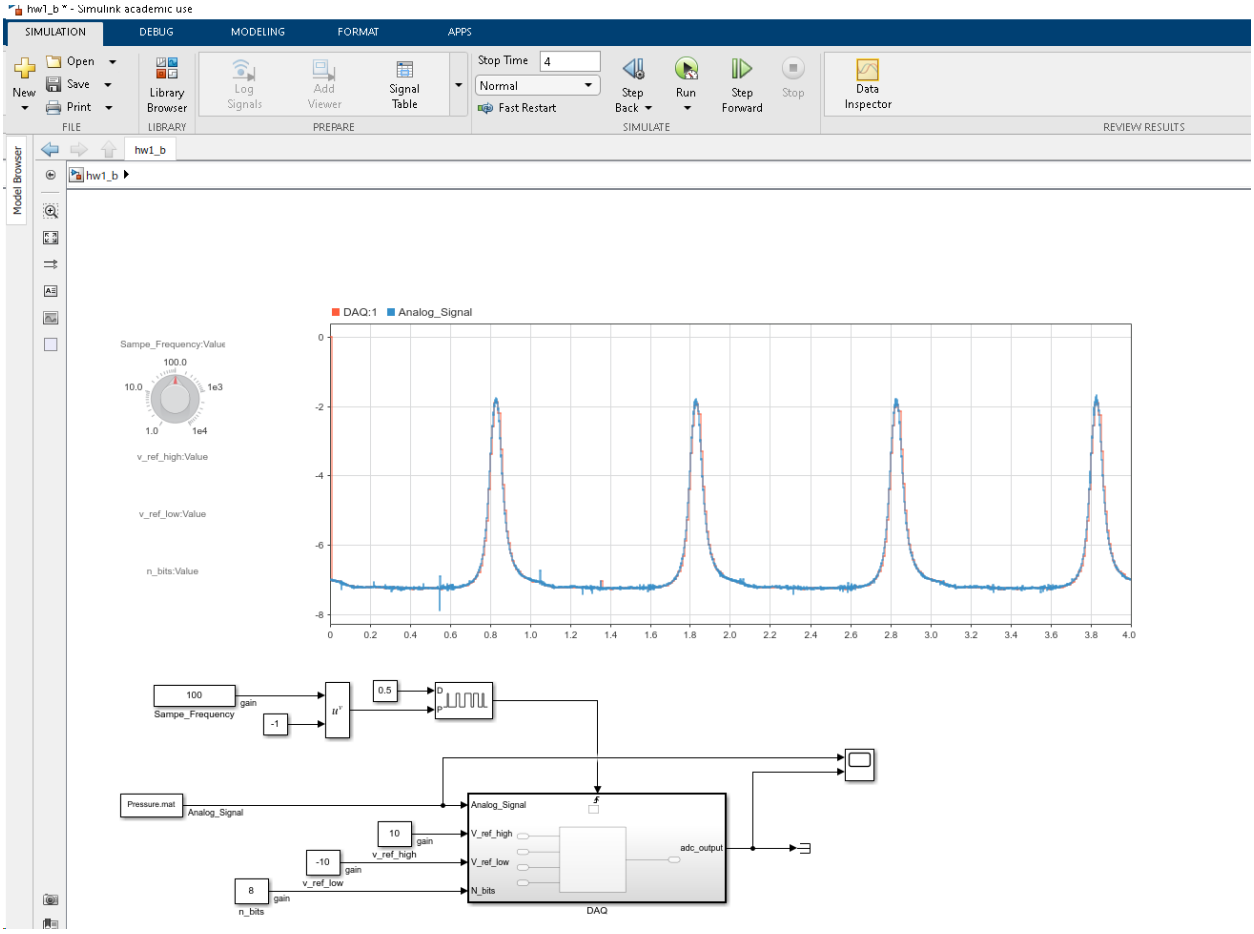


Problem 2

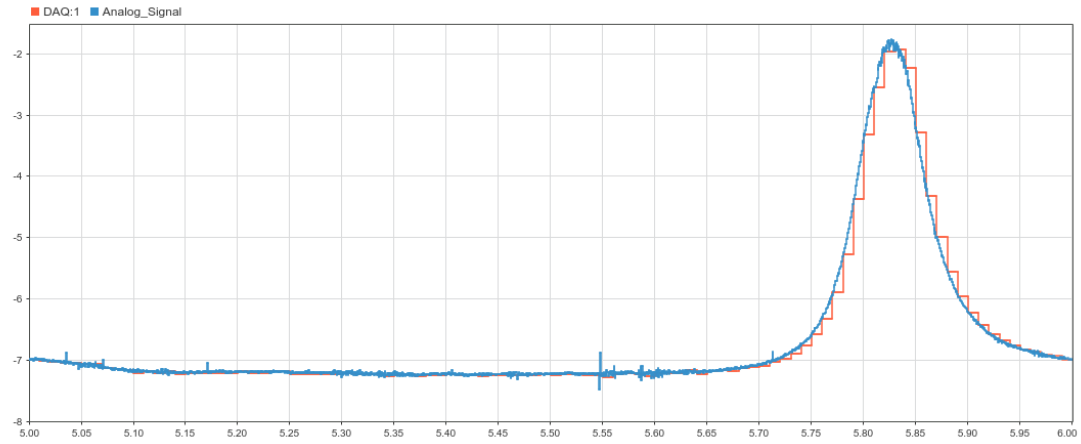
See problem 3

Problem 3

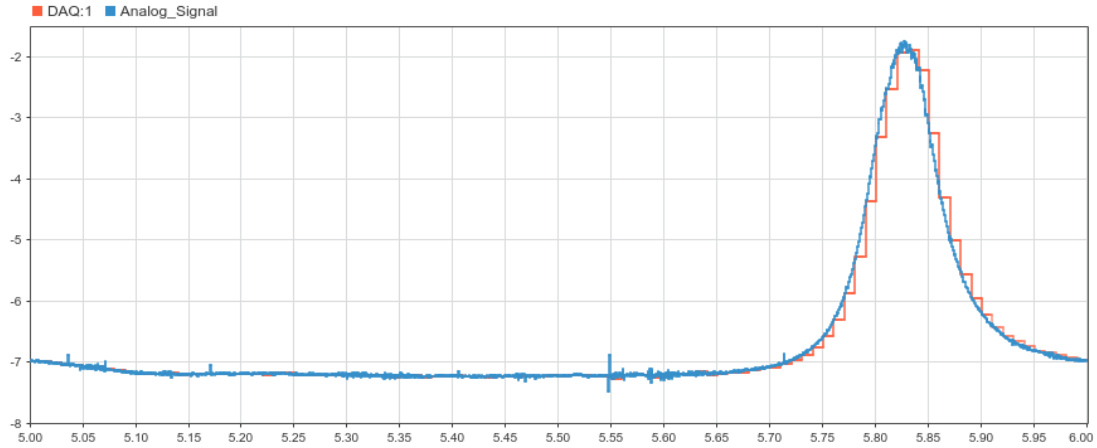
Simulink Model



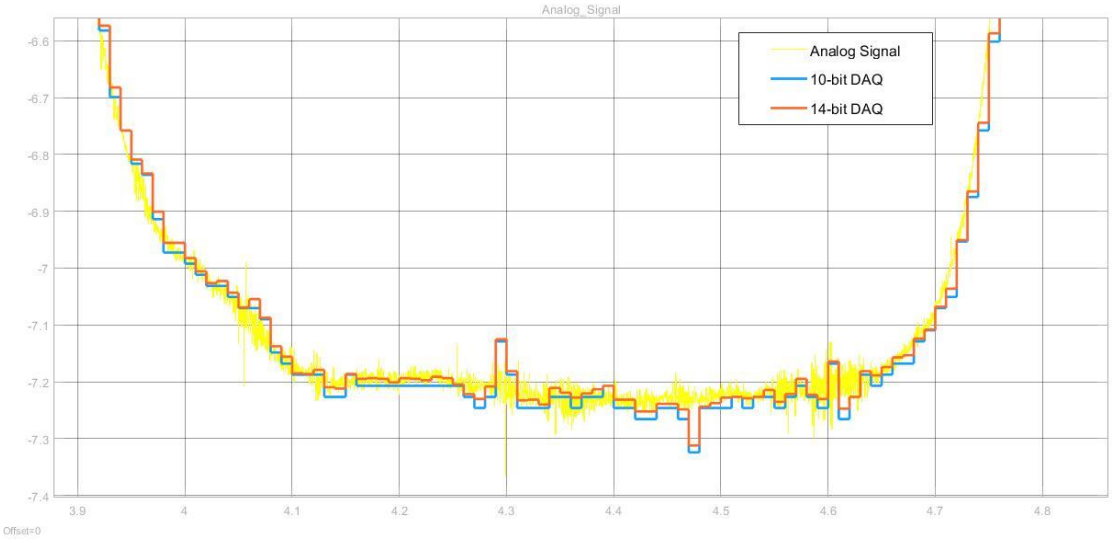
10 bit, -10V to 10V @100Hz Sampling Frequency



14 bit, -10V to 10V @1000Hz Sampling Frequency



Difference between 10 & 14 bit resolution



Problem 4

To calculate the bit resolution of the In-Cylinder Pressure measurement, the minimum (non-zero) $\Delta Voltage$ from one reading to another was calculated. I shifted the array by 1 and subtracted it from itself. Then,

$$\Delta V_{min} = \min(\Delta V[\Delta V \; ! = 0]) = \; 3.0500e-04$$

$$bit\ resolution = \; log_2\left(\frac{V_{full\ scale}}{\Delta V_{min}}\right) = log_2\left(\frac{20V}{3.0500e-04}\right) = 16\ bit\ resolution$$