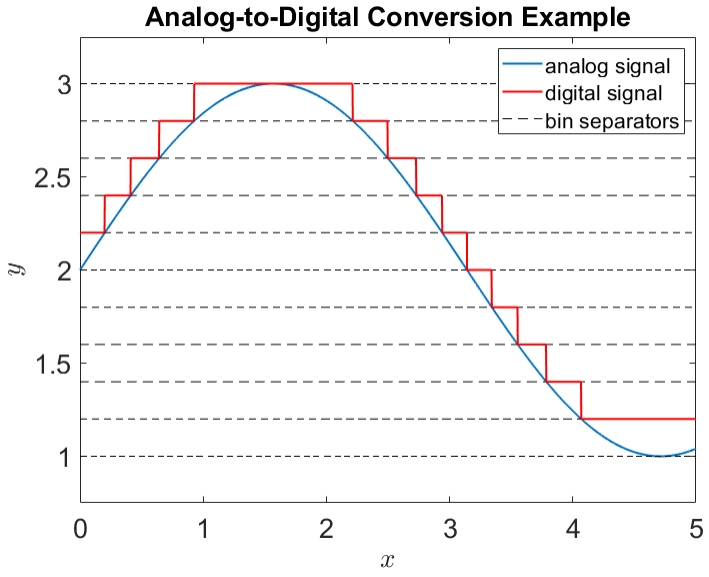
MAE 215
Spring 2023
Quiz 2
Time Limit: 50 Minutes

Name (Print): _____

Student ID: _____

Converting physical signals to signals that a computer can process is a critical step in using computers to process experimental data. The physical signal is called the *analog* signal and the computer-friendly signal is called the *digital* signal. The analog signal is a continuous signal in time; that is, there are effectively infinite data points contained within any finite time interval. We have seen in our study of scientific programming that computers cannot handle infinities–this is why we have to define x vectors with a finite number of data points when we want to plot some function f, for example. It follows that if we want to use computers to analyze physical signals we must first convert these continuous signals to discrete, digital signals.

The process of converting continuous signals to discrete signals is generally termed analog-to-digital conversion, and the figure below provides a visual representation of this concept. The basic idea is that a continuous signal can be discretized by considering the value of the continuous signal to fall into a number of different *bins*. Each of these bins represents some range of values for the function. The figure shows a continuous function that has been discretized into 10 different bins of equal size. Here, the value of the digital function is set to the upper value of the bin when the value of the analog function falls within the bounds of said bin. For example, from $1 \lesssim x \lesssim 2.25$ the analog function value falls within the uppermost bin, and thus the digital function value is set to the upper value of this bin for this range of x values.



Analog signals are generally converted to digital signals using an analog-to-digital converter (ADC). ADCs are generally constructed from many different electronic components, but we can mimic the performance of an ADC with some computer code. The next page shows a script file (also downloadable from Canvas) that somehow mimics the function of an ADC. Read through, run, improve, or otherwise play with this script file in the days leading up to Quiz 2. Every question on Quiz 2 will be related to the script and the general concept of analog-to-digital conversion.

```
%% A2D_Conversion.m

%%

clear, clc, close all

%%

x = linspace(0,5,1e5);
y = 1+x.^2;

nmax = 1e2;
y2 = zeros(nmax,length(y));

n = 1;

tol = 0.1;
maxErr = 100;

while maxErr > tol

    bin_size = (max(y)-min(y))/n;

    for k = n:-1:1
        a = max(y) - k*bin_size;
        b = y >= a;
        y2(n,b) = max(y) - bin_size*(k-0.5);
    end

    Err = abs((y2(n,:)-y)./y);
    maxErr = max(Err);

    n = n+1;

    if n > nmax
        break
    end

end

req_bins = n-1;
y2 = y2(1:req_bins,:);
```