# Homework 1

Student Name: _____

AuE 8930: Machine Perception and Intelligence
Instructor: Dr. Bing Li, Clemson University, Department of Automotive Engineering

* Refer to Syllabus for homework grading, submission and plagiarism policies;
* Submission to Canvas (Due: Tues. Feb. 4, 2020 11:59 pm), including:
  - This document (with answers), and with your program results/visualization;
  - A .zip file of source code (and data if any) with names indicating question number;

1. Visualize continuous period signal $x(t) = 2 + 3 * \cos(500\,\pi\,t) + 2 * \cos(1000\,\pi\,t) + 3 * \sin(2000\,\pi\,t)$ in time-domain (axis: Amplitude and t) and visualize its digital Fast Fourier transform (axis: Amplitude and f). Given Sampling frequency as 1K HZ. (5 points)

2. Visualize discrete signal $x(k) = 0$ for $k \in [0\ 499]$ and $= 1$ for $k \in [500\ 1000)$ μs (sampling frequency as 1M HZ) in time-domain (Amplitude over t) and visualize its digital Fast Fourier transform (Amplitude over f), find its -3dB (called half-power) bandwidth frequencies ($f\_low$, $f\_high$) in frequency spectrum. (10 points)

3. For discrete signal $x(k) = 20$ for $k \in [0\ 499]$, add a normally distributed random noise $n(k)$ (mean 0, variance 1) to the signal, and get $x'(k) = x(k) + n(k)$. Then, apply a normalized (mean 0, standard deviation 1) Gaussian kernel (windows size 3 and 11 respectively as a low pass filter, then rescale all elements to make sure the sum is 1) to perform convolution $y(k) = x'(k) * h$ by using basic arithmetic operations only.
   a) Visualize both $x(k)$ and $x'(k)$ in one figure (10 points)
   b) Visualize both $x(k)$, and $y(k)$ based on kernel window size 3 in one figure (10 points)
   c) Visualize both $x(k)$, and $y(k)$ based on kernel window size 11 in one figure (5 points)
      Tip: You may consider using zero-padded for edges during convolution operation

4. Find an online open dataset (such as but not limited to KITTI, NUSCENES) containing Radar data and its labelling, and pick up partial data of a Radar.
   a) Visualize a continuous time frames (like a few seconds) for the data of a Radar in 2D drawing visualization; (5 points)
   b) Visualize objects by its labelled data on the above visualization; (15 points)

5. 2~3 pages of survey on a particular 1D physical signal related to vehicles (40 points), (such as: 1D Radar, vibration/friction/temperature/speed/… signals). The grading of this question is based on the contents which the survey covers:
   - The importance of this signal measurement (5 points);
   - The challenges of measuring this physical signal data (5);
   - Existing solutions of measuring this physical signal (15);
   - Existing problems of measuring this physical signal (5);
   - Others not limited to above (such as novelty, organization, et al) (10)
   * You are encouraged to include any drawing/table in the report;
   * Attention: Survey a particular 1D signal, not survey/compare multiple 1D signals.
   * Attention: use "…" [1] to cite any sentence you literally copied and use … [1] to cite a content you referred to, with reference list in the end;