Homework 6

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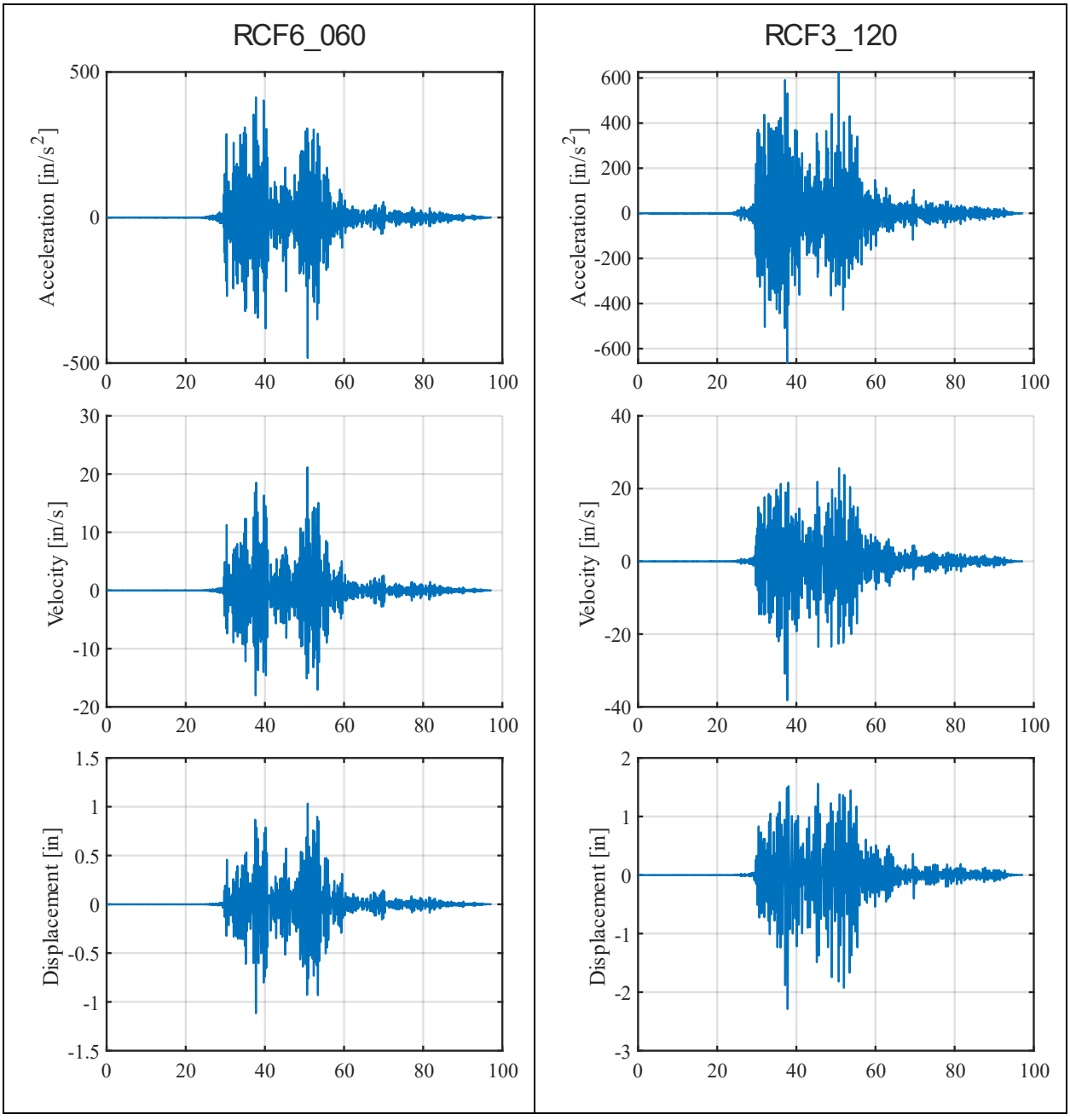
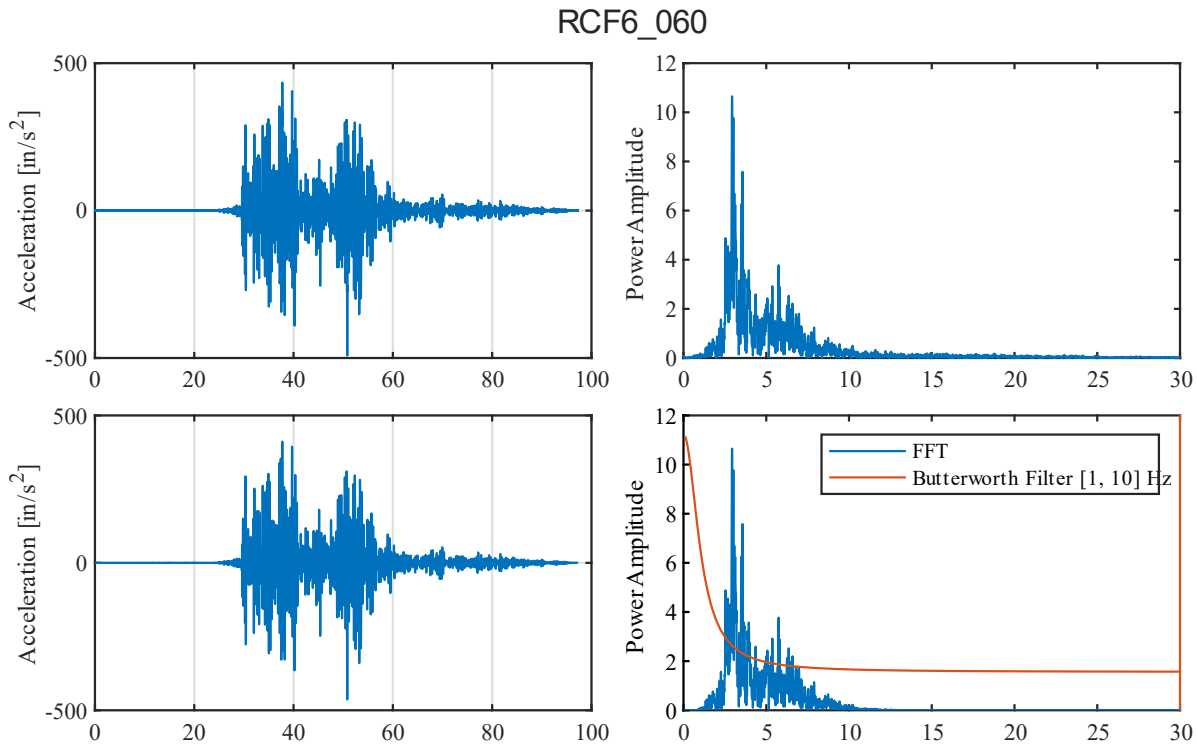
SE 267A Signal Processing and Spectral Analysis

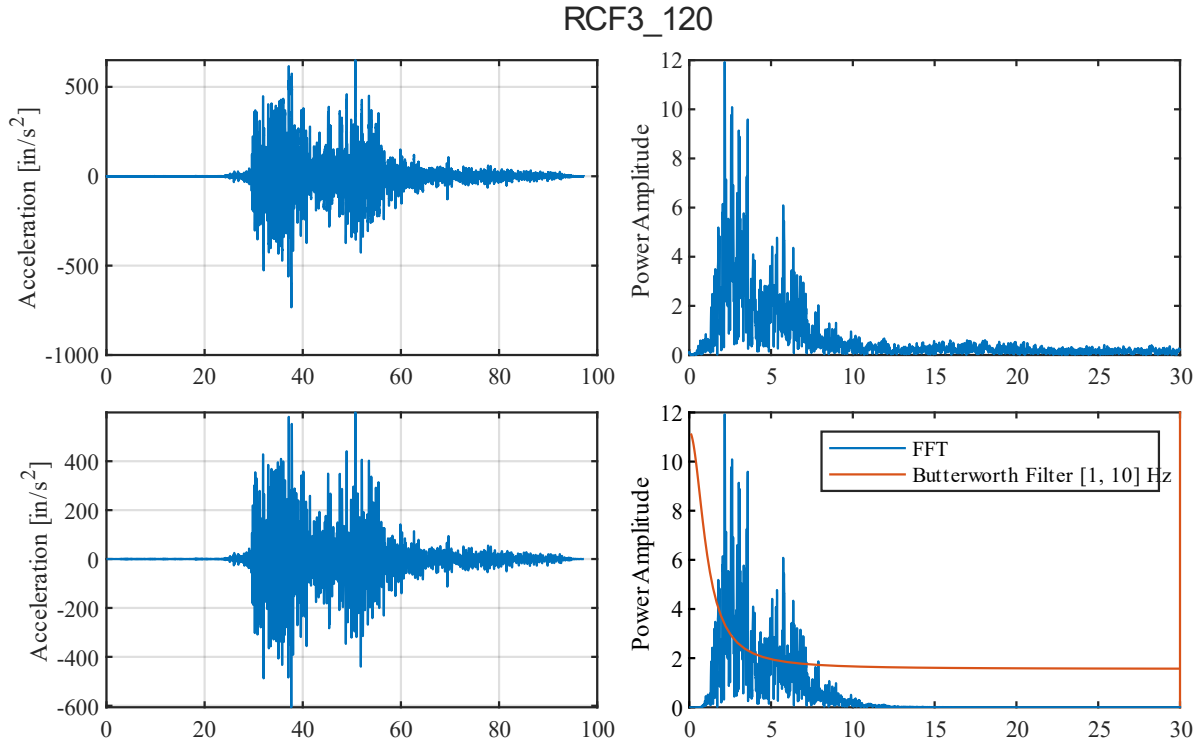
Problem 6

The objective of this homework was to examine getting the displacement of a civil structure from an acceleration time history data set. Two sensors were chosen for this assignment: RCF6_060 and RCF3_120.

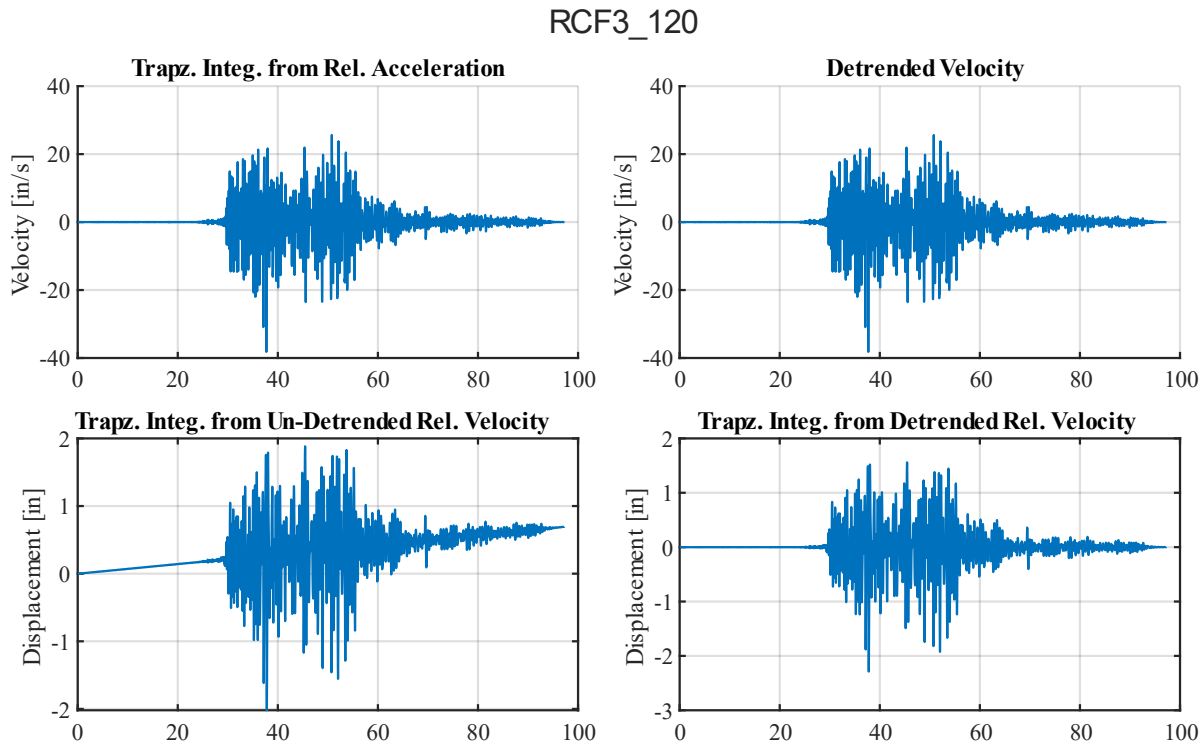


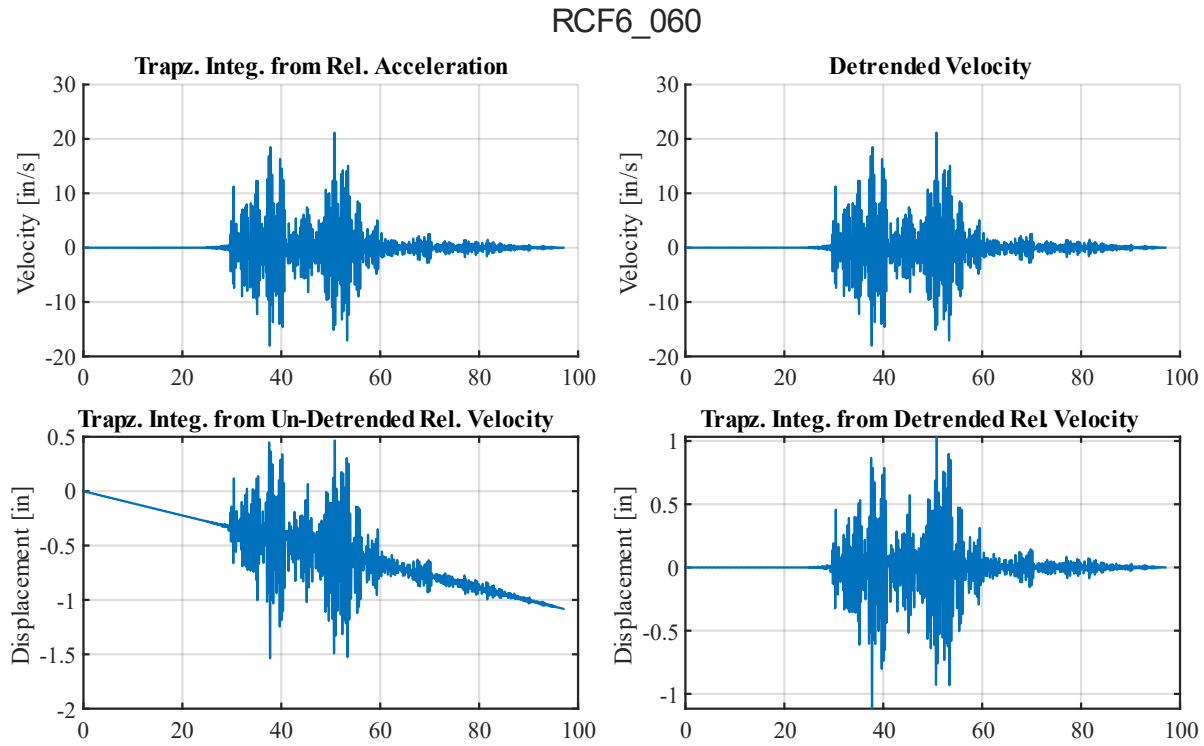
Here the Butterworth filter is demonstrated. Although there is no noticeable difference in the time history, the butterworth filter is shown to decrease high frequency signals within the signal.





The importance of detrending the velocity is shown below. Although the trend is barely noticeable, the constant will lead to spurious growth of the displacement.





```
%% Import Data
clc; clear; clf;
data = readtable("Homework-2 data set-RCF-Four Specimen Test Data.xlsx");
%%
fs = 200; % Sampling rate
dt = 1/fs;
ii = 0;
for RC = ["6_060", "3_120"]
    ii = ii + 1;
    figure(ii); clf; clc
    tiledlayout(3,1,"TileSpacing","compact","Padding","compact")
    udd_g = data.("RCF" +RC+"_A10"); % Base acceleration
    udd_a = data.("RCF" +RC +"_A04"); % Building level acceleration

    % Remove DC Gain if any
    preTriggerTime = 10; % seconds; Pretrigger time based on visual observations
    udd_g = udd_g - mean(udd_g(1:fs*preTriggerTime));
    udd_a = udd_a - mean(udd_a(1:fs*preTriggerTime));

    udd_r = udd_a - udd_g; % Relative acceleration
    npt = length(udd_r);
    t = (1:npt) * dt;
    g = 386.4;
    udd_r = udd_r *g;

    % Pass Through low pass filter
    n = 4; % order of butterworth filter
    Wn = [1, 20] ./(fs/2); % Cutoff Frequencies
    ftType = 'bandpass'; % Option
    [b,a ] = butter(n, Wn, ftType);
    udd_r = filtfilt(b,a,udd_r);
    nexttile;
    plot(t, udd_r);
    grid on;
    ylabel("Acceleration [in/s^2]")

    % Integration to velocity
    ud_r = cumtrapz(t, udd_r);
    ud_r = detrend(ud_r, 1);
    nexttile(); hold on;
    plot(t, ud_r);
    grid on;
    ylabel("Velocity [in/s]")

    % Integration to displacement
    u_r = cumtrapz(t, ud_r);
    nexttile()
    plot(t, u_r);
    grid on;
    ylabel("Displacement [in]")

    sgtitle("RCF" +RC, interpreter = 'none')
end
```