Homework #2
AE6505 Kalman Filtering, Spring 2022
Prof. Gunter
Assigned: 2-1-22
Due: 2-11-22 (2-14-22 for DL Students)

Homework is due by 11:59p on the indicated due date, and should be submitted electronically via Canvas. Late homework will not be accepted without prior permission from the instructor. In-class verbal due date announcements override projected dates in the lecture plan. Please submit your materials as two files. The first should be a writeup of your solutions, complete with any figures, explanations, etc., in .pdf form. This is the document that will be graded, i.e., do not embed solutions in your code, or require the grader to run your code to get any results. Homework should be professional, legible, indicate units, and sufficiently describe all important steps in a solution. Your final answer for each problem should be boxed or clearly indicated. You are welcome to scan any pages that are handwritten, but please make sure any such pages are clear and legible. Deductions will be made for incomplete solutions and improper formats. In addition to the .pdf file, upload any Matlab files that you have developed to generate the results described in your writeup as a single .zip file. The Matlab code you submit should be able to be run without modification, so do not include hardcoded file paths.

1. Exercises 3.5, 3.7, 3.9, 3.13 from the text by Simon.

2. When estimating parameters from satellite orbit or attitude data, there is often unmodeled residual signal. The residual may be a product of insufficient knowledge of the dynamics, or simply as a matter of convenience (i.e., intentionally using a lower fidelity force model for computational efficiency). The residual signals are strongest at the once-per-revolution and twice-per-revolution periods, but may also have other minor offsets and drift rates. If you are simply interested in removing this residual signal, i.e., it is only a noise source in your analysis, you can simply estimate and remove it as part of your data processing scheme. These parameters are often called "empirical" or "bucket" or "soak up" parameters. The file "emp_acc_data.txt" contains a time series of data residuals that cover a time span of ten orbits, from a satellite in a 500 km altitude orbit (which has period of 5677 sec). From this data set

   (a) Describe the equations and major components (X, G(X), H, etc.) necessary for the least squares estimation scheme. You should attempt to estimate a bias, drift, one-per-rev periodic, and twice-per-rev periodic signal from the times series. For this problem, the standard least squares approach should be sufficient, i.e., without weighting.

   (b) Show the values of your estimated parameters.

   (c) Plot the original noisy data set, with an overlay of your final estimated curve.

   (d) Compare the pre-fit and post-fit statistics (i.e., mean, std. deviation).