ECE 238 - Lab 1.

Hint → See plots on last page. You will be working to create similar plots for problems "8." and "9."

1. - Use "Lab 0" document to build a simulink model to collect encoder data.

2. - Use a polynomial fit to estimate velocity for some sub-section of (interesting) data. (Use about $\frac{1}{2}$-1 sec of data.)
   (HINT - Use both "polyfit" AND "polyder"...)

   (HINT: Shift encoder data to start at "zero" BEFORE filtering for derivative...)

   (HINT: Use "filter" in MATLAB.)

3. - Create a filter in MATLAB to calculate velocity from the encoder data (in MATLAB).

4. - Calibrate data → How many radians per encoder ct?? (or) Distance per encoder ct??

System ID

- We know the downward-pointing (stable) pendulum w/ no actuation should obey this equation of motion:

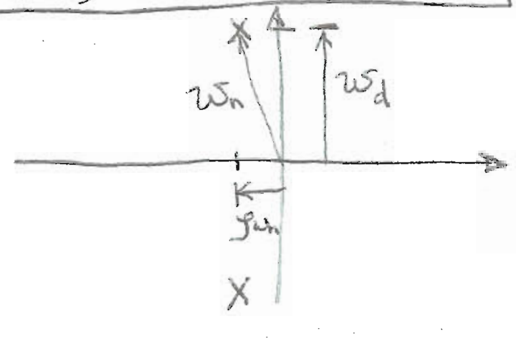
(1) $J\ddot{\theta} + B\dot{\theta} + gm\frac{L}{2}\sin\theta = 0$

Linearized (for small θ), this is close to:

(2) $J\ddot{\theta} + B\dot{\theta} + gm\frac{L}{2}\theta = 0$

The left-hand side is the "characteristic equation" giving poles for the pendulum (linearized) dynamic system.
We can rewrite (2) in Laplace notation as:

(3) $s^2 + 2\zeta\omega_n s + \omega_n^2 = 0$



5. From the data below, estimate:

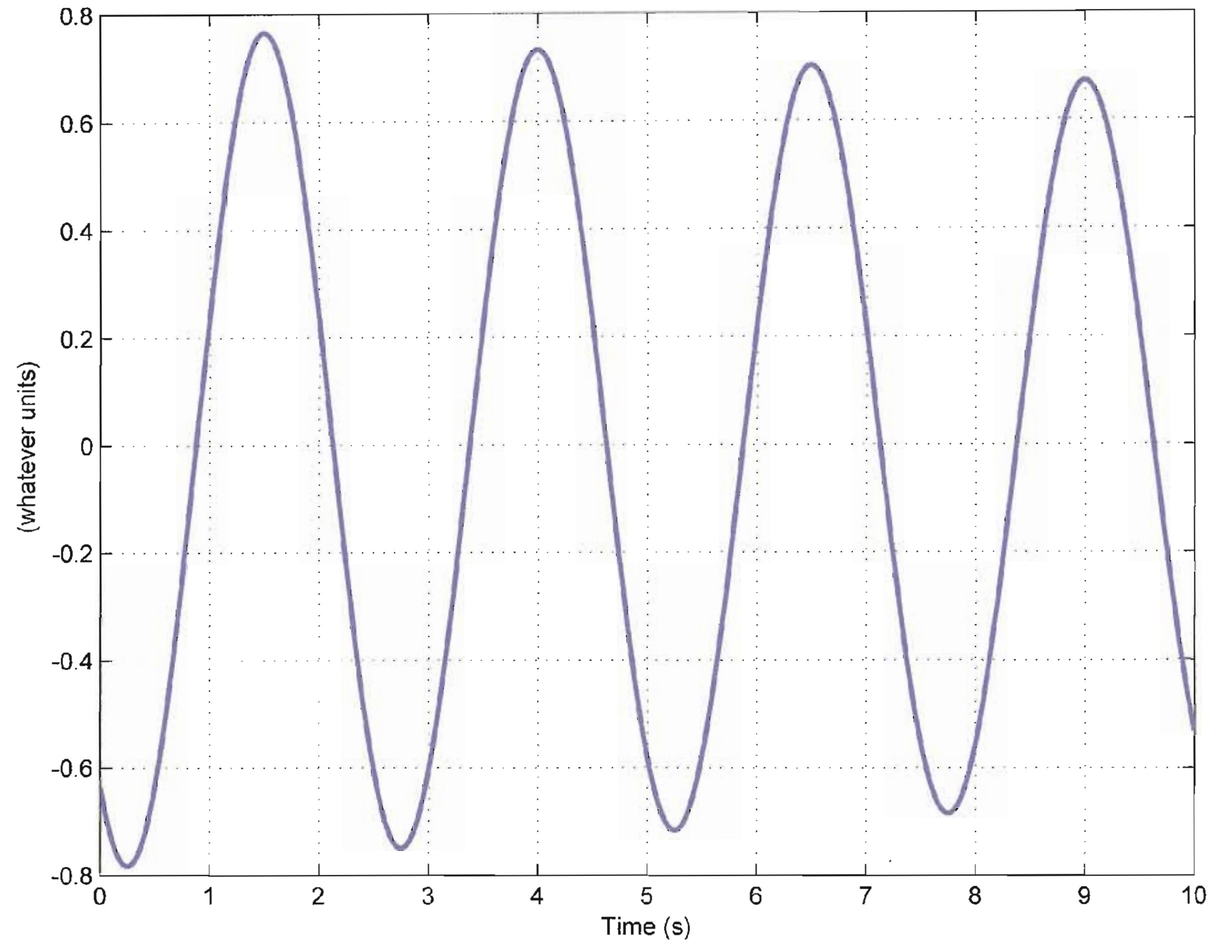
$\omega_d =$ ________ , $\zeta =$ ________ , $\omega_n =$ ________

$s_1 =$ ________ $s_2 =$ ________ (poles)

6. Write the characteristic eqn. and new poles you expect for the <u>inverted</u> configuration of the same pendulum. $s_1 =$ ________

$s_2 =$ ________

____



7. Given eqn. 2 & your answers in 5., what would the length of the pendulum be? (Assume a solid rod...)

$L \approx$ ________

Filter Implementation

8. Finally, implement a digital filter within your model to output velocity of the encoder.

   - Create a single MATLAB plot that shows both a "polynomial fit" estimate of velocity (as in problem 2.), which should be smooth & have no added time delay, and the output of the "velocity" filter from your simulink model.

(4 attachments in your email!!) * email 1) some version of this figure (MATLAB ".fig" file, PDF, JPG, ...)
AND 2) your simulink ".mdl" file,
AND 3) your code for the polynomial est.
AND 4) a ".mat" file with encoder pos. & velocity data.

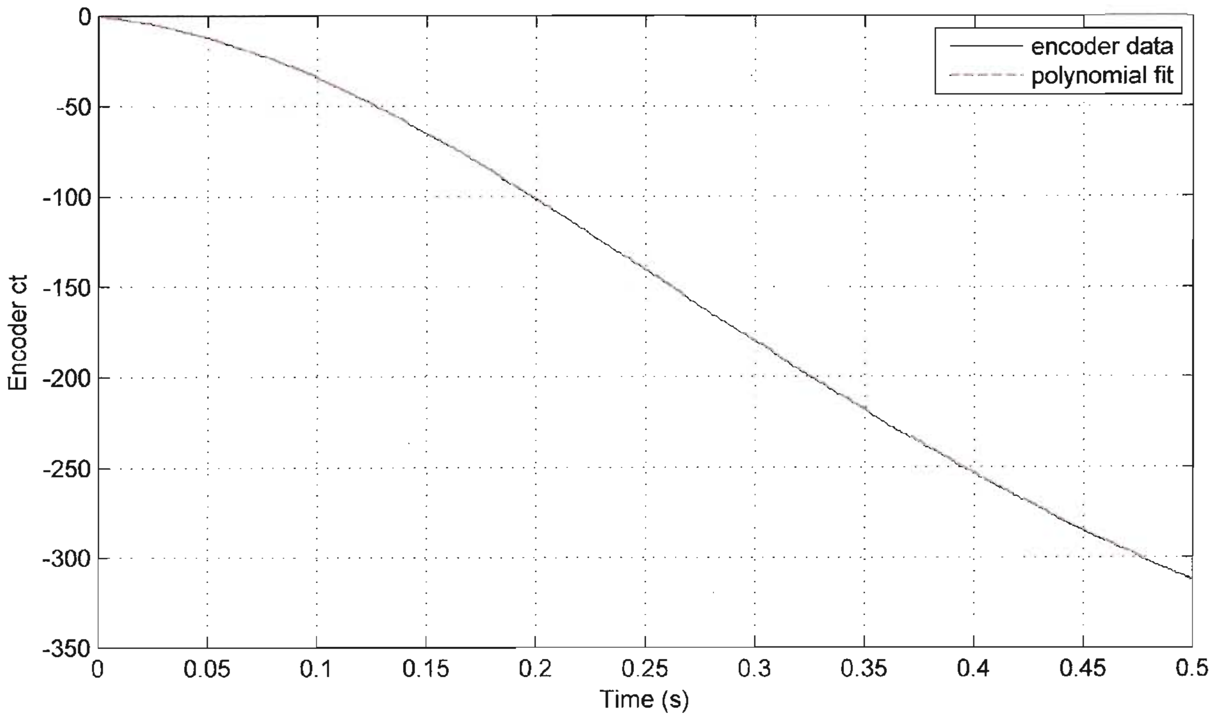
To: katiebyl@ece.ucsb.edu

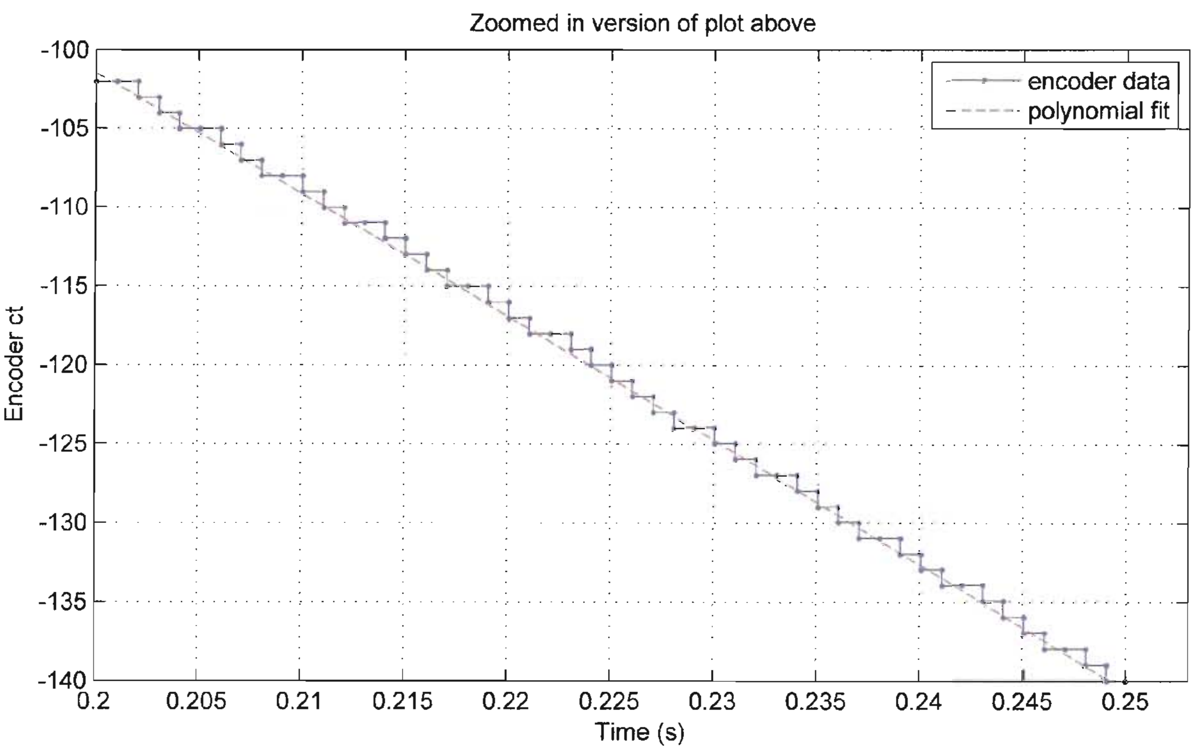
(You must also "cc" all group members you worked with, so they have copies & I know who was in what group!!)

9. HOMEWORK - To be done individually.

Improve your filter (or other estimation method) for encoder velocity. BE SURE IT WILL WORK IN REAL TIME, although you may simulate using MATLAB & emailed encoder (raw) position data at home.

Example of encoder data ...





Example of a plot for part 8.