MECH 435L
Assignment I

Read First Before you Start

The assignment should be submitted in 2 parts (zipped into a single file). 1 part is a document file which addresses each question (derivation, code, simulink model, and calculations and plots. Whatever applies). The zip file should also contain the matlab files and simulink models.

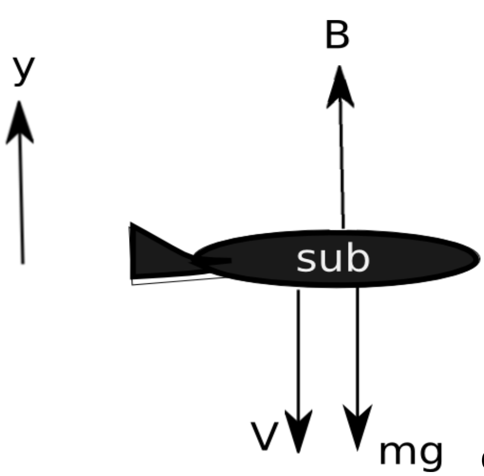
You will be graded based on the document file, the matlab code and simulink models should be there for reference only (you will be penalized if you don't submit the matlab and simulink models) so please make sure that the document file that you submit is complete and not missing any parts.

Problem 1:

To control the vertical position of a submarine, dedicated pumps would expel or inhale water from its buoyancy tanks in order to vary the amount of buoyancy force applied.

The forces acting on the submarine are (1) the weight (assumed constant) (2) the viscous drag (assumed linear for small motion $V = by'$) (3) the buoyancy force ($B = \rho_w * V_{disp} * g$) where is the volume of water displaced by the submarine (V_{disp}= volume of submarine – volume of water inside the tanks).

Let $I = \rho_w V_{disp} - m$ be the input to the system.

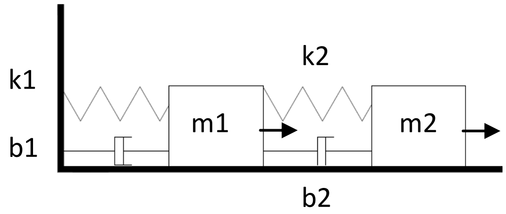


Given:

- Density of water : ρ_w=1000kg /m^3
- Mass of submarine : m=100kg
- Damping gain : b=10N.s/m

1. Derive the equations of this system
2. Build a simulink model where the submarine is modeled as a masked subsystem. The input to the subsystem is I=10 and the outputs are the position y and velocity y'.
3. Plot the output position and the velocity on 2 separate plots (the simulation should run for 50 seconds).

Problem 2:



Given a horizontal double mass spring damper system with the following parameters:

b1 = 250; b2 = 10; k1 = 1000; k2 = 50; m1 = 5000; m2 = 100;

Derive the mathematical model governing this system.

Write an ODE45 solver in MATLAB to solve this system for time between 0-200s, for an input F1 = F2 = 1N and initial conditions x_1 = 0m , x_2 = -0.2m, v_1 = 0m/s, v_2 = 0m/s.

The output plot should show the positions x_1, x_2, as well as the relative motion of x_2 with respect to x_1.