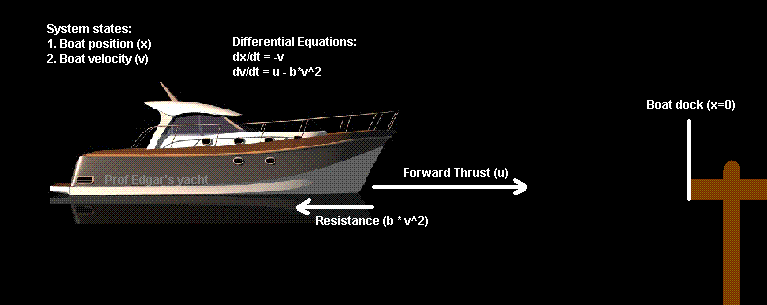
ChE 391 Homework #3 due 2/23

Boat docking problem:

Docking a motor boat successfully without crashing into the dock can yield a sense of satisfaction to the boat owner/operator. Being able to do this quickly, however, represents a significant challenge to your boatmanship skills. If one ignores waves, wind, and steering effects, the movement of a boat can be described as a tradeoff between viscous forces and the force of the motor/propeller. If these forces are not equal, then the boat can either speed up or slow down. The forward thrust can be expressed as ((m/sec2)/(1000 kg)), the resistance can be expressed as , where ((N∙ sec/m)/(1000 kg) is the measure of friction, which is the damping factor in this system.



Let the boat position to be , the boat velocity is . Assume the mass of the boat is *m*=1000 kg, then the boat docking system can be represented by the following equations.

The system equation is:

Here , , where is the final time when the boat reach the dock.

The initial condition on velocity and position is (m), and (m/s). When the boat reaches the dock, the final velocity should be below 0.05 m/s. Try to find the optimal control strategy which can minimize the value of . Simulate your solution by MATLAB and show the responses of *x(t)*, and . Use the principles of optimal control as discussed in class augmented by application of nonlinear programming using tools available such as Excel Solver. Interpret your solution in terms of practicality.