ECE 874 - Spring 2013 **Test 2 Out-of-Class Component** Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(20 points total)

Instructions:

1. The test is due on Wednesday March 6 in class at 11:15AM.
2. You must show all steps in your solutions
3. Your exam solutions are to be your own work, you are not to give or receive assistance of any kind on this exam.

Given the system:

The geometry of the ship motion is defined in the coordinate system *Xo, Yo*, while the motion of the ship itself is described in the relative coordinate system *(x, y)*, which is fixed to the ship. The motion of the ship is shown in the figure. In the system, the controlled parameter is the ship course, *x1(t)=ψ(t)*, while the controlling parameter is the rudder angle, *u(t)=δ(t).* The equations describing dynamic characteristics of the ship were derived assuming a constant forward velocity *v*.

|  |  |
| --- | --- |
|  | *v* |

Design a control system for steering a ship on a course.

1. (10 pts) Use the hand-crafted backstepping control design approach to design the control input *u(t)=δ(t)* such that the ship stays on the course *x1(t)=ψ(t)=0.* Be sure to include control gains with your feedback terms. Show all work and that all signals are bounded. 
2. (10 pts) Simulate the control system in Simulink using the initial condition *x1(0)=ψ(0)=0.2, x2(0)= x3(0) =0*.
   1. Show *x1(t), x2(t), x3(t)* on one plot.
   2. Show *u(t)* and the intermediate control signals on one plot