

Problem Set 2**Sailing Dinghy Design**

This problem centers on the design of a sailing dinghy. The work should be done with MaxSurf

1. Generate a “starting point” of the sailing dinghy by using Maxsurf to scale the length, width and depth of the design you did in the getting started exercise in class. Scale the length to 3.5 meters, the total breadth to 1.6 meters and the total Depth (draft plus freeboard) to 0.9 meters. If you would like to have a little less freeboard for your own reasons, you can scale the depth to 0.7 or 0.8 meters.
2. Make sure the control point net has four rows and five columns. Except for the column at the bow, all other columns should have their control points in a plane. Adjust the control point positions slightly to achieve this if necessary. If your “getting started” design has only four columns add a fifth column so there are columns along the length at approximately 0, 25, 50, 75 and 100% of the length.
3. Run the upright hydrostatics and you should find that the displaced weight is different than the desired weight of 300 kg. Adjust the three lowest control points in each column to change the displacement and get a shape which pleases you and has a displaced weight very close to 300 kg in seawater with a density of 1025 Kg/m^3 . You can also move the DWL up or down to alter the displacement. Make sure that the fore and aft perpendiculars are set at the final bow and stern endings of the design waterline. When you run the upright hydrostatics you will see, amongst other things, the LCB and the prismatic coefficient. Your design values should have a C_p of about 0.6 and an LCB about 0.16 meters aft of amidships.
4. Make a grid with 11 equally spaced sections including the aftmost and forwardmost sections. Set five waterlines located at $z = -0.2, 0.0, 0.2, 0.40$ and 0.6 meters. Set four buttocks located at $y = 0.0, 0.2, 0.4,$ and 0.6 meters.
5. Make printed graphs of your sections, waterlines and buttocks.
6. Make and print the upright hydrostatics data from Maxsurf. Use center of gravity heights of 0.5 m for the 175 kg crew, 4 m for the 25 kg sail and rig and 0.1 m for the 100 kg hull.
7. Design a centerboard and rudder for the dinghy. The centerboard should have a span of about 1 meter, and a mean chord of about 0.4 meters. The rudder should

have a span (below the DWL) of about 0.8 meters and a mean chord of about 0.3 meters. Thickness fractions of 9% to 11% are reasonable values.

8. The sailing stability of the boat, at about 10 degrees of heel, a typical upwind sailing angle, is 10 times the righting moment per degree and 175×0.8 kg-m from the two person crew on the rail. Design a catboat (single almost triangular sail) sailplan which will give about the same amount of heeling moment at an apparent wind speed of 17 knots (8.75 m/s). The density of air is about 1.2 kg/m^3 , depending on temperature. Use a mean lift coefficient of 1.2. Base the heeling moment on presuming that the center of aerodynamic side force is 40% of the sail height above the bottom of the sail. At this height, the center of force is about 35% of the sail chord aft of the leading edge. Approximate the side force as the lift force. When we later do sail aerodynamics, you will learn how much drag is associated with a prescribed lift so you will be able to calculate the side force for exactly for a given apparent wind angle.
9. Find the center of lateral resistance of the boat by approximating the side force on the hull and centerboard as the force on a centerboard alone, but extended up to the waterline with its center $\frac{1}{4}$ of the chord length aft of the leading edge at a height that is 40% of the total draft below the waterline, and a force on the rudder that is 20% of the force on the keel and hull and located $\frac{1}{4}$ of its chord length aft of the leading edge at a depth of 40% of the rudder span.
10. From the above information, determine the fore and aft location of the mast such that the longitudinal positions of the aerodynamic side force and the hydrodynamic side force coincide.
11. Run large angle stability analysis on the boat using Hydromax. Find the angle of heel for maximum GZ with the crew on the rail and with the crew on centerline.