

Problem Set 1 Addendum - Solutions

Preliminary Design of a Sloop Rigged Yacht

The solutions are computed using the same Matlab program developed for Problem Set 1 with few modifications for part 0.

Numerical Results

11. Again a high accuracy and a low accuracy set of results are given. These results are for the new, smaller keel, while the mast still has the original height. The amount of ballast in this case exceeds the 5% of the total lead, being around 6.5%. The Dellembaugh angle is still well below 20 degrees.

High Accuracy Results

Maximum Beam	3 m at $x = -1.6667$
Maximum Draft	0.5 m at $x = 0$
Canoe body displacement	6 m ³
Canoe body LCB	0.43106 m aft of amidship
Canoe body VCB	0.15916 m below DWL
Keel displacement	0.27563 m ³
Keel root chord	1.5 m
Keel LCB	0.033482 m forward of amidship
Keel VCB	1.2857 m below DWL
Keel VCG	1.2857 m below DWL
Rudder displacement	0.017472 m ³
Rudder LCB	4.74 m aft of amidship
Rudder VCB	0.6392 m below DWL
Yacht displacement	6.2931 m ³ or 6450.4244 Kg.
Mass of lead	3030.4244 Kg
Mass of keel, incl. structure	3020.2813 Kg
Empty volume in keel	0 m ³
Internal ballast	150.1432 Kg
Yacht VCG	0.087944 m below WL
Yacht VCB	0.20983 m below WL
Yacht LCB	0.42267 m aft of amidship
Sectional area coefficient	0.72
Metacentric height GM	1.6053 m
Yacht BM	1.7271 m
Yacht KB	0.29017 m
Yacht KG	0.41206 m
Waterplane area	20.7438 m ²
LCF	0.71412 m aft of amidship
Mast height	15 m
Main area	34.5 m ²
Main CE	6.8 m above WL
Jib Area	27.95 m ²
Jib CE	5.5333 m above WL
Total Area	62.45 m ²

Sailplan CE	6.2331 m above WL
Vertical CLR	1.1667 m below WL
Dellenbaugh angle	12.4857 deg
Dellenbaugh angle (actual SA)	14.7331 deg

Low Accuracy Results

Maximum Beam	3 m at x = -1.6667
Maximum Draft	0.5 m at x = 0
Canoe body displacement	6 m ³
Canoe body LCB	0.43615 m aft of amidship
Canoe body VCB	0.15906 m below DWL
Keel displacement	0.27563 m ³
Keel root chord	1.5 m
Keel LCB	0.033482 m forward of amidship
Keel VCB	1.2857 m below DWL
Keel VCG	1.2857 m below DWL
Rudder displacement	0.017472 m ³
Rudder LCB	4.74 m aft of amidship
Rudder VCB	0.6392 m below DWL
Yacht displacement	6.2931 m ³ or 6450.4244 Kg.
Mass of lead	3030.4244 Kg
Mass of keel, incl. structure	3020.2813 Kg
Empty volume in keel	0 m ³
Internal ballast	150.1432 Kg
Yacht VCG	0.087944 m below WL
Yacht VCB	0.20974 m below WL
Yacht LCB	0.42753 m aft of amidship
Sectional area coefficient	0.72
Metacentric height GM	1.609 m
Yacht BM	1.7308 m
Yacht KB	0.29026 m
Yacht KG	0.41206 m
Waterplane area	20.5414 m ²
LCF	0.67002 m aft of amidship
Mast height	15 m
Main area	34.5 m ²
Main CE	6.8 m above WL
Jib Area	27.95 m ²
Jib CE	5.5333 m above WL
Total Area	62.45 m ²
Sailplan CE	6.2331 m above WL
Vertical CLR	1.1667 m below WL
Dellenbaugh angle	12.4568 deg
Dellenbaugh angle (actual SA)	14.6991 deg

12. As shown in 11, the Dellembaugh angle is still too small. To find the correct mast height, the main Matlab program has been modified so that it keeps changing the mast height and performs the entire calculation until the Dellembaugh angle falls within desired interval. The results show that a mast height of either 18 m or 18.25 m satisfies the stability criteria, with the second one being closest to the desired value. And the amount of ballast is below the desired 5% limit at 2.7%.

High Accuracy Results

Maximum Beam	3 m at x = -1.6667
Maximum Draft	0.5 m at x = 0

Canoe body displacement	6 m ³
Canoe body LCB	0.43106 m aft of amidship
Canoe body VCB	0.15916 m below DWL
Keel displacement	0.27563 m ³
Keel root chord	1.5 m
Keel LCB	0.033482 m forward of amidship
Keel VCB	1.2857 m below DWL
Keel VCG	1.2857 m below DWL
Rudder displacement	0.017472 m ³
Rudder LCB	4.74 m aft of amidship
Rudder VCB	0.6392 m below DWL
Yacht displacement	6.2931 m ³ or 6450.4244 Kg.
Mass of lead	2910.355 Kg
Mass of keel, incl. structure	3020.2813 Kg
Empty volume in keel	0 m ³
Internal ballast	30.0737 Kg
Yacht VCG	0.12811 m above WL
Yacht VCB	0.20983 m below WL
Yacht LCB	0.42267 m aft of amidship
Sectional area coefficient	0.72
Metacentric height GM	1.3892 m
Yacht BM	1.7271 m
Yacht KB	0.29017 m
Yacht KG	0.62811 m
Waterplane area	20.7438 m ²
LCF	0.71412 m aft of amidship
Mast height	18.25 m
Main area	42.625 m ²
Main CE	7.8833 m above WL
Jib Area	34.0058 m ²
Jib CE	6.6167 m above WL
Total Area	76.6308 m ²
Sailplan CE	7.3212 m above WL
Vertical CLR	1.1667 m below WL
Dellenbaugh angle	20.307 deg
Dellenbaugh angle (actual SA)	23.9622 deg

Low Accuracy Results

Maximum Beam	3 m at x = -1.6667
Maximum Draft	0.5 m at x = 0
Canoe body displacement	6 m ³
Canoe body LCB	0.43615 m aft of amidship
Canoe body VCB	0.15906 m below DWL
Keel displacement	0.27563 m ³
Keel root chord	1.5 m
Keel LCB	0.033482 m forward of amidship
Keel VCB	1.2857 m below DWL
Keel VCG	1.2857 m below DWL
Rudder displacement	0.017472 m ³
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Yacht displacement	6.2931 m ³ or 6450.4244 Kg.
Mass of lead	2910.355 Kg
Mass of keel, incl. structure	3020.2813 Kg
Empty volume in keel	0 m ³
Internal ballast	30.0737 Kg
Yacht VCG	0.12811 m above WL

Yacht VCB	0.20974 m below WL
Yacht LCB	0.42753 m aft of amidship
Sectional area coefficient	0.72
Metacentric height GM	1.3929 m
Yacht BM	1.7308 m
Yacht KB	0.29026 m
Yacht KG	0.62811 m
Waterplane area	20.5414 m ²
LCF	0.67002 m aft of amidship
Mast height	18.25 m
Main area	42.625 m ²
Main CE	7.8833 m above WL
Jib Area	34.0058 m ²
Jib CE	6.6167 m above WL
Total Area	76.6308 m ²
Sailplan CE	7.3212 m above WL
Vertical CLR	1.1667 m below WL
Dellenbaugh angle	20.2527 deg
Dellenbaugh angle (actual SA)	23.8982 deg