Propeller Design Assignment
Fall 2006

A lifting line code (PVL) is setup and run for a particular propeller design.
The input file and resulting design output file are attached. The input file gives the operating point specifics as well as the inflow distribution and design chordlength distribution on the propeller.

The full scale propeller runs on a ship with the following characteristic:

Diameter: 5 m
Ship Speed: 13 m/s
RPM: 156
Required Propeller thrust: 991.5 kN
Depth at Prop Centerline: 8m
Vapor pressure: 2500 Pa
Water Density: 997 kg/m3
Axial inflow velocity variation +/-1 m/s

The output file shows the non-dimensional circulation distribution G, induced velocities Flow angles and drag coefficient.

1)Find the optimal efficiency for this propeller from Kramer's Diagram

Using the data for a NACA a=0.8 meanline and NACA 65A010 Thickness section determine the blade section design at the r/R=0.697 radius. The max. thickness of this section is chosen at to/C = 0.04

2) Find the lift coefficient for this section as well as the camber ration fo/c and proper angle of attack

3). Determine the blade angle and pitch P/D for this section.

4).Will this section cavitate at this radius under the design operating conditions for this ship? Use Brockett diagram to estimate

5). Use the matlab m-file vlm.m provided to analyze the 2D section at ideal angle of attack. Plot the pressure distribution Cp vs. chordwise position. At what position on the blade would cavitation first occur under these conditions?

PVL input file

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 32          : NUMBER OF VORTEX PANELS OVER THE RADIUS
 10          : MAXIMUM ITERATIONS IN WAKE ALIGNMENT
  1          : HUB IMAGE FLAG: 1=YES, 0=NO
 0.5         : HUB VORTEX RADIUS/HUB RADIUS
 11          : NUMBER OF INPUT RADII
  5          : NUMBER OF BLADES
 1.0         : ADVANCE COEFFICIENT, J, BASED ON SHIP SPEED
 0.600       : DESIRED THRUST COEFFICIENT, CT
 0.000       : HUB UNLOADING FACTOR: 0.0=OPTIMUM (NO UNLOADING)
 0.000       : TIP UNLOADING FACTOR  1.0=REDUCED LOADING
 1.000       : CRP SWIRL CANCELLATION FACTOR: 1.0=NO CANCELLATION
  r/R      c/D      Cd       Va/Vs    Vt/Vs
0.20000  0.17400  0.00800  1.00000  0.00000
0.25000  0.19700  0.00800  1.00000  0.00000
0.30000  0.22900  0.00800  1.00000  0.00000
0.40000  0.27500  0.00800  1.00000  0.00000
0.50000  0.31200  0.00800  1.00000  0.00000
0.60000  0.33700  0.00800  1.00000  0.00000
0.70000  0.34700  0.00800  1.00000  0.00000
0.80000  0.33400  0.00800  1.00000  0.00000
0.90000  0.28000  0.00800  1.00000  0.00000
0.95000  0.24000  0.00800  1.00000  0.00000
1.00000  0.00200  0.00800  1.00000  0.00000
```

PVL output design for assignment

Ct= 0.6000
Cp= 0.8392
Kt= 0.2356
Kq= 0.0524
Va/Vs= 1.0000
Efficiency= 0.7150

r/R	G	VA	VT	UA	UT	BETA	BETAI	Chord/D	CD
0.20048	0.012889	1.00000	0.00000	0.05119	-0.10192	57.796	63.334	0.17419	0.00800
0.20433	0.012905	1.00000	0.00000	0.05276	-0.10307	57.303	62.895	0.17576	0.00800
0.21199	0.012995	1.00000	0.00000	0.05590	-0.10527	56.337	62.031	0.17890	0.00800
0.22338	0.013231	1.00000	0.00000	0.06060	-0.10830	54.940	60.770	0.18377	0.00800
0.23840	0.013668	1.00000	0.00000	0.06681	-0.11187	53.168	59.154	0.19082	0.00800
0.25691	0.014331	1.00000	0.00000	0.07443	-0.11565	51.093	57.237	0.20106	0.00800
0.27872	0.015217	1.00000	0.00000	0.08328	-0.11929	48.794	55.078	0.21512	0.00800
0.30362	0.016295	1.00000	0.00000	0.09313	-0.12245	46.353	52.745	0.23122	0.00800
0.33138	0.017522	1.00000	0.00000	0.10367	-0.12490	43.848	50.304	0.24637	0.00800
0.36172	0.018842	1.00000	0.00000	0.11458	-0.12645	41.347	47.820	0.26003	0.00800
0.39436	0.020199	1.00000	0.00000	0.12552	-0.12706	38.909	45.350	0.27285	0.00800
0.42898	0.021538	1.00000	0.00000	0.13619	-0.12674	36.576	42.941	0.28614	0.00800
0.46524	0.022811	1.00000	0.00000	0.14637	-0.12559	34.379	40.631	0.29986	0.00800
0.50281	0.023974	1.00000	0.00000	0.15588	-0.12376	32.336	38.448	0.31291	0.00800
0.54131	0.024990	1.00000	0.00000	0.16461	-0.12139	30.457	36.408	0.32415	0.00800
0.58037	0.025826	1.00000	0.00000	0.17251	-0.11866	28.743	34.522	0.33326	0.00800
0.61963	0.026454	1.00000	0.00000	0.17959	-0.11570	27.190	32.792	0.34021	0.00800
0.65869	0.026847	1.00000	0.00000	0.18587	-0.11264	25.792	31.218	0.34487	0.00800
0.69719	0.026981	1.00000	0.00000	0.19139	-0.10959	24.540	29.795	0.34696	0.00800
0.73476	0.026830	1.00000	0.00000	0.19621	-0.10661	23.423	28.516	0.34610	0.00800
0.77102	0.026376	1.00000	0.00000	0.20041	-0.10376	22.433	27.373	0.34147	0.00800
0.80564	0.025599	1.00000	0.00000	0.20404	-0.10110	21.559	26.359	0.33205	0.00800
0.83828	0.024490	1.00000	0.00000	0.20715	-0.09865	20.793	25.465	0.31757	0.00800
0.86862	0.023042	1.00000	0.00000	0.20982	-0.09643	20.126	24.683	0.30007	0.00800
0.89638	0.021261	1.00000	0.00000	0.21207	-0.09445	19.550	24.006	0.28231	0.00800
0.92128	0.019161	1.00000	0.00000	0.21396	-0.09271	19.060	23.428	0.26639	0.00800
0.94309	0.016764	1.00000	0.00000	0.21552	-0.09123	18.650	22.943	0.24822	0.0080
0.96160	0.014101	1.00000	0.00000	0.21677	-0.08999	18.316	22.546	0.22128	0.00800
0.97662	0.011213	1.00000	0.00000	0.21775	-0.08901	18.052	22.233	0.18391	0.00800
0.98801	0.008143	1.00000	0.00000	0.21847	-0.08827	17.857	22.001	0.13812	0.00800
0.99567	0.004940	1.00000	0.00000	0.21894	-0.08778	17.729	21.848	0.08618	0.00800
0.99952	0.001656	1.00000	0.00000	0.21917	-0.08754	17.665	21.772	0.03048	0.00800