13.012 Marine Hydrodynamics for Ocean Engineers
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Fall 2004

HW #9
(Optional, but good practice for exam!?!)

Out: 30 November 2004
"Due": 7 December 2004

Assume water density $\rho = 1000$ kg/m^3

Problem 1: An inventor gives you a propeller and claims that it can give 50N of thrust at a boat speed of 1.8 m/s and uses only 100 watts of power (to the propeller shaft):

The propeller is 0.2m in diameter and rotates at 1200 RPM (20 RPS). It has 3 blades.

a) What is the efficiency of the propeller at this condition?
b) What is the Non-dimensional operating point for this prop (Ct, Kt & J)?
c) Is this efficiency possible (Actuator Disk)?
d) What is the best efficiency that this real propeller could achieve ideally (use Kramer diagram)?
e) Practically what would you expect the efficiency of a typical propeller to be? (i.e use given B-series chart)

Problem 2: The following data is collected for a model propeller tested at MIT's water tunnel:

Water speed m/s	RPM	Thrust (N)	Torque (N-m)
0.00	1200.00	50.00	0.50
0.20	1205.00	45.20	0.48
0.40	1202.00	40.10	0.46
0.60	1201.00	35.15	0.44
0.80	1195.00	29.91	0.42
1.00	1200.00	25.00	0.40
1.20	1201.00	20.02	0.38
1.40	1198.00	14.98	0.36
1.60	1200.00	9.98	0.34
1.80	1201.00	5.00	0.32
2.00	1199.00	0.00	0.30

The test propeller was 0.12 m in diameter with 2 blades

The full scale ship using the full scale version of this propeller has the following resistance characteristics:

Thrust: 10000N @ Ship Speed: 10 m/s

1. Plot the MIT data in a non-dimensional propeller plot showing Kt,Kq, eff. vs. J.
2. What is the maximum efficiency of the propeller? At what Kt, J does this occur?

3. What is the Diameter and RPM that the full scale propeller should have for best efficiency? Hint write down the equations for Kt and J and and plug in what you know to solve for N and D.

4. What will the torque and shaft power be for the full scale propeller under these conditions?