2.23 Hydrofoils & Propellers
Exam #1
March 16, 2007
1 1/2 Hour – Open Book

Name:_____

Note: For all problems assume fluid density is 1000 kg/m3

1) [15 pts]For the vortex system shown below find the total velocity at point P. (show work).

2) [32 pts] New bow planes are designed to trim an autonomous submarine (one on each side of the hull). The foils are flat each with an elliptical planform area of 0.015 m2 and a span of 0.25m . The lift required to trim the hull is 25 N at a vehicle speed of 4 m/s. If the viscous drag coef. (based on planform area) is 0.008 find:

a) Lift coef. of one foil

b) Estimate the induced drag on both foils

c) Estimate the total drag on both foils

d) If the hull moves at 4 m/s find the power required to overcome the drag of the foils.

3) [56 pts]A 4 bladed propeller is placed on a submarine hull and is measured to have the following performance:

Diameter: 5 meter (R=2.5m)
Hub radius: 1 m
Rotational speed: 120 rpm
Ship speed: 10 m/s
Propeller thrust: 500000 N

a) Compute J, Kt and Ct for this propeller

b) Find the maximum possible efficiency for a propulsor of this size.

c) Estimate the ultimate wake diameter as well as the average axial induced velocity ua* at propeller disk using actuator disk theory.

d) Find the efficiency of an equivalent propeller from Kramer's diagram.

e) Find the efficiency and pitch if the propeller were a B-series 4 bladed propeller (data curves provided).

f) Assuming an actuator disk, estimate the induced velocity on the propeller disk at r/R=0.7.

g) At r/R =0.7 the Induced tangential velocity is ut*= -0.8 m/s and the circulation at r/R=0.7 is Γ= 7.0 m2/s Using the induced axial velocity from part f find: inflow angle β, wake angle βi, Draw an accurate velocity diagram at r/R=0.7.

h) If the chord at r/R=0.7 is 1m and the drag coefficient of the section is Cd=0.008 Find the axial force/span and tangential force/span at this radius.