Introduction to Marine Hydrodynamics (NA235)

(2014-2015, 2nd Semester)

Assignment No.10

(5 problems)

(5 problems, given on June 18th, need not submit)

Problem 1: A test on drag force on a submarine is performed in a wind tunnel. The length ratio of the model to prototype is $1/10$. Following parameters of the test have been measured. Pressure in the wind tunnel is 20 atmospheric pressures. Wind speed in the tunnel equals $12m/s$, and the drag force on the model is $120N$. If flow in the tunnel is laminar, please ① estimate the corresponding speed of the prototype submarine, and ② estimate the corresponding power needed to drive the prototype submarine at that speed.

Problem 2: Given ratio of a ship model to its prototype, $1:50$. In a model test, when the model is towed at a speed of $u_m = 1.33m/s$, measured the drag force, $r_m = 9.81N$. Please estimate the speed of and the drag on the prototype ship for the following two cases. ① If the dominant drag is due to wave generation. ② If the dominant drag is due to viscous friction.

Problem 3: A resistance test on a ship model, scaled from the prototype at ratio $1:40$, in towing tank was performed. Total resistance of the ship model measured is $3.2kgf$. It is known that frictional resistances of the ship model and the prototype can be estimated from expressions $0.37u^{1.95}(kgf/m^2)$ and $0.29u^{1.8}(kgf/m^2)$ respectively, where u is the ship speed in m/s. Now the prototype ship is traveling at sea (salt water) at speed $12m/s$, please estimate its total resistance. Area of the wetted hull surface of the prototype ship is equal to $2500m^2$. The towing tank is filled with fresh water.

Problem 4: Resistance of a sphere in an unbounded fluid domain at very low speed is investigated by Stokes. It is found that the resistance varies with the speed V, dynamic viscosity μ and diameter D of the sphere, but independent on the fluid density. Please find the dependence of resistance F on those parameters by means of dimensional analysis.

Problem 5: An ocean wave of height H is generated by a wind blowing at speed U. Denote densities of air and water as ρ_a and ρ respectively. Water depth is d, and the wave is away from the shore with distance L. Gravitational acceleration is expressed in symbol g. Generally wave height H depends on all those parameters. Please find

the general dependence based on Π theorem.