Introduction to Marine Hydrodynamics (NA235)

(2014-2015, 2nd Semester)

Assignment No.8

(7 problems, given on June 4th, submitted on June 11th, 2015)

Problem 1: A layer of heavy viscous fluid in gravity flows on an inclined surface. Give thickness of the layer h, atmospheric pressure P_a, fluid dynamic viscosity μ, and angle of the inclined surface with horizon α, please determine velocity distribution of the fluid layer and its flow rate.

Problem 2: Two parallel plates, apart with distance a, enclosed two separated fluids of dynamic viscosity, μ_1, μ_2, and thickness, a_1, a_2, respectively. The lower plate is horizontally fixed on the earth, while the upper one moves at a constant speed, u_0, along the plate. If horizontal pressure gradient along plates vanishes, please determine velocity and pressure distributions of the flow field.

Problem 3: Derive velocity distribution of a steady viscous flow of a liquid film on a vertical wall. Gravity is the only volumetric force. The

liquid is assumed incompressible, and the flow can be looked as laminar.

Problem 4: Consider a two dimensional viscous flow: u and v are velocity components along x- and y- axis respectively, and ς is the vorticity. Please derive vorticity transport equation from **N-S** equation, and explain each term physically.

Problem 5: Given two coaxial circular cylinders of length h, and radii r_1 and r_2 $(< r_1)$ respectively. When they rotate around the common axle with angular velocity ω_1 and ω_2 respectively, please ① give out tangential velocity distribution, and ② write down torque on the inner cylinder.

Problem 6: A pipe flow: its average velocity is $u_m = 1m/s$, radius of the pipe is $r_0 = 0.1m$. The pipe is assumed smooth. Calculate ① velocity at the center of the pipe, and ② the shear stress on the pipe wall, when temperature of the water in pipe is 20^oC.

Problem 7: Describe the difference of Moody chart from Nikuradse diagram.