Introduction to Marine Hydrodynamics (NA235)

(2014-2015, 2nd Semester)

Assignment No.3

(Eight problems, submitted on March 30th, 2015)

Problem 1: Consider two flows:

$$(a)\begin{cases} v_x = 1 \\ v_y = 2 \end{cases}; \quad (b)\begin{cases} v_x = 4x \\ v_y = -4y \end{cases}$$

(1) Determine if the flow (a) has the stream function ψ. If does, solve the stream function and plot graph of the stream function;

(2) Determine if the flow (b) has the velocity potential φ. If does, solve φ, and plot the equipotential lines.

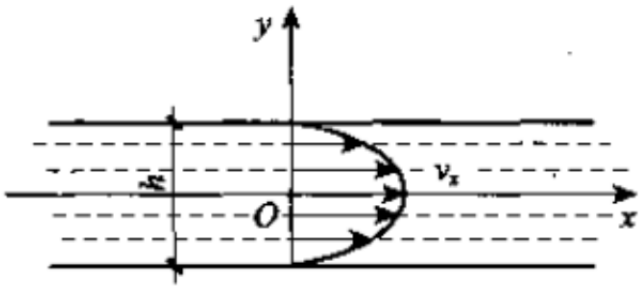
Problem 2: Consider a plane flow field $v_x = 1 + 2t$, $v_y = 3 + 4t$. Determine: (1) Streamline equation; (2) at t=0, the shapes of three streamlines passing points (0, 0), (0, 1), (0, -1); (3) at t=0, the pathline equation of a fluid particle locating at point (0, 0).

Problem 3: The velocity components of an incompressible plane flow are

given as: $v_x = 1 - y$, $v_y = t$. Determine: (1) at t=0, the pathline equation of a particle passing point (0, 0); (2) at t=1, the streamline equation of a particle passing point (0, 0).

Problem 4: The velocity distribution of an incompressible plane flow is given as: $v_x = x^2 + 2x - 4y$, $v_y = -2xy - 2y$. Determine if the flow: (1) satisfies the continuity equation; (2) is rotational; (3) has the velocity potential and stream function. If does, solve them.

Problem 5: Consider the flow between two parallel plates separated by distance $h = 2$ m, the velocity distribution is: $v_x = 10 \times \left(\frac{1}{4} h^2 - y^2 \right)$ (m/s), $v_y = 0$, axis x coincides with the center line of the two plates. Determine the stream function of the flow field and plot the streamlines in between the two plates.



Problem 6: The velocity potential of an incompressible plane potential flow is: $\varphi = 0.04x^3 + axy^2 + by^3$, units of x, y are m, unit of the potential function is m^2/s. (1) Determine the constants a, b; (2) Compute the pressure difference between points (0, 0) and (3, 4), assume the density of the fluid is 1300 kg/m^3.

Problem 7: Consider an incompressible plane flow, the module of its velocity vector is: $q = \sqrt{x^2 + y^2}$ **.** The streamline equation of the flow is: $y^2 - x^2 = c$, where c is a constant. Determine the velocity distribution of this flow.

Problem 8: The stream function is known as: $\psi = x^2 - y^2$. (1) Determine velocity potential φ; (2) Neglect the mass force, determine the pressure distribution in the flow field.