

Problem Set-1 in Fluids

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This Problem Set serve as a scholarship of 50percent in the joining of test series for GATE-2012 in AE

You can send any of the format(word, Latex file, PDF, or scan solution to the below given Gmail IDs

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Aerodynamics, Irrotational Flows, Viscous Flow

Problem 1 : Suppose a line vortex of circulation Γ is suddenly introduced into a fluid at rest. Assume that the flow is incompressible. Show that the solution is

$$u_{\theta} = \frac{\Gamma}{2\pi r} \exp(-r^2/4\nu t) \quad (1)$$

Sketch the velocity distribution at different times. Calculate and plot the vorticity; how does it diffuse outwards ?

Problem 2 : A lighter than air prolate ellipsoid moves in air with constant speed U . If this air vehicle oscillates simple harmonically about its center with a small amplitude A in a vertical plane then find the time dependent surface downwash expression at the (i) shoulders, and (ii) at the front end rear ends

Problem 3 : Find the phase difference between the displacement and the downwash for a flat plate oscillating simple harmonically in a free stream at a zero angle of attack.

Problem 4 : Using the general solution for the first order differential equations obtain the relation between the velocity potential and the

acceleration potential

Problem 5 : What is a *shockdoublet* in unsteady transonic flow?

Problem 6 : For a given free stream Mach number M , obtain the stagnation pressure coefficient in terms of M . Find the limit of the stagnation pressure coefficient for M approaching infinity

Problem 7 : Comment on Area Rule in Transonic Flow.

Problem 8 : The flow past a cylinder very near a wall might be simulated by doublet images. Explain why the result is not very successful and the cylinder shape becomes badly distorted.

Problem 9 : Explain the system of images needed to simulate the flow of a line source placed unsymmetrically between two parallel walls. Compute the velocity on the lower wall at $x = a$. How many images are needed to estimate this velocity within 1 percent?

Problem 10 : We do not need to define perturbation potential for the acceleration potential. Why?

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Note : The detailed Solutions of this Problem Set will be given with test papers to the registered students