Assignment 3
Phy 426, 2017
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DUE: Wed 15 Mar, 2017

Question 1. Standing wave in fjord

Consider a *hydrostatic* wave in being forced at the mouth of a rectangular fjord of depth H and length L. The sea-surface height at the mouth of the fjord is prescribed by the sea-surface height in the ocean $\eta(0,t) = \eta_O \cos(\omega t)$, where ω is the tidal frequency.

1. Derive an expression for the the sea-surface height η as a function of x in the fjord assuming that there is no energy dissipation in the fjord. Describe the response in terms of the length of the fjord, L. Also note that there are sometimes nulls in the response in the fjord. Where are they?

2. What is the relationship between $u(x,t)$ and $\eta(x,t)$ in the fjord? What happens to the velocity at the mouth as the fjord length approaches the resonant length?

Question 2. Numerical Potential Flow

The text describes an iterative procedure for solving for solving for potential flow. Consider a channel, 50 m wide, z=0 in the centre, with a 2-D transport of 1 $\mathrm{m^2s^{-1}}$ in steady state. Two half cylinders are in the flow along the lower boundary, with their centers at (0.,-25) and radius 20 m, and (40,-25), radius 14 m.

For all of these, please turn in your code. I did this in Matlab and Python.

1. Solve, numerically, for the flow and plot 50 evenly-spaced streamlines (in streamline space). (HINTS: The code for this can be very short in a matrix language like matlab or numpy in Python. You only need one for-loop to do the iterations on ψ. You need to set the lower boundary value of $\psi = 0\ \mathrm{m^2s^{-1}}$, and the upper boundary to $\psi = 1\ \mathrm{m^2s^{-1}}$.)

2. Construct a solution with two doublets and calculate the streamlines from that, and *quantitatively* compare with your fully numerical solution. What is the major difference between the two solutions, and how would you make your numerical solution more like the analytical? (HINTS, in class we did the analytical solution using cylindrical co-ordinates, but that is awkward here, where there are two doublets. Instead, just form the complex flow potential $w(z)$ and contour the imaginary part. Also note that the values of *psi* are arbitrary to a constant, so you may want to set the lowest streamline's value to zero to compare with your numerical answer.)