Homework problems on Fluid Dynamics

(1.63J/2.21J)

Chiang C. Mei, 2002

Ex4-oilslick.tex

Ex 4. *Motion of water beneath a spreading oil film.*

When oil is spilled on the sea surface, motion of the oil film and water beneath are coupled. The physics involves surafce tenion, viscosity and nonlinearity and is complicated. Consider an idealized model for partial understanding of the water motion induced by the spreading oil film. (Cox and Foda (197?)).

Let the sea surface at $y = 0$ be intially free. From $t = 0$ two plastic sheets descends and are pulled away from $x = 0$ to $x \to \pm\infty$ at the constant speed U along the sea surface. Boundary layers are developed in water.

1. Set up the governing equations for unsteady boundary layers.

2. State the initial and boundary conditions .

3. Integrate the momentum equation across the boundary layer. and get the depth-integrated momentum equation (Karman's momentum integral equation).

4. Assume a parabolic profile for the boundary layer flow, to find a partial diffential equation for the boundary layer thickness $\delta(x, t)$

5. Solve the hyperboic differential equation for δ. Discuss the results