MT3261 Viscous Fluid Flow: Parallel flow above an oscillating plate.

Here's an illustration of the flow profile u(y,t) for the flow above a periodically oscillating plate which is located in the plane y=0. The parallel flow above the plate is governed by the equation

$$\frac{\partial}{\partial t}\mathrm{u}(y,t) = \nu\left(\frac{\partial^2}{\partial y^2}\mathrm{u}(y,t)\right)$$

The plate oscillates in the plane y=0 and the velocity boundary condition is given by

$$\mathrm{u}(y=0,t) = U\cos(\omega t)$$

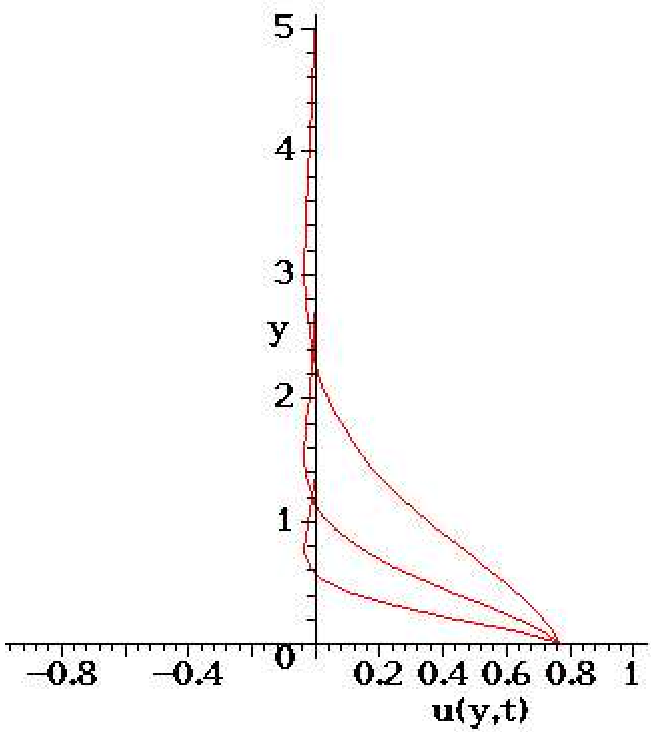
The periodic solution for U=1 which is animated below is

$$\mathrm{u}(y,t) = \mathbf{e}^{(-\delta y)}\cos(\omega t - \delta y)$$

where

$$\delta = \frac{1}{2}\sqrt{2}\sqrt{\frac{\omega}{\nu}}$$

Three velocity profiles are shown: They represent the solutions for $\omega = 1$ and for $\delta = 1, 2\ and\ 4$. In all cases the velocity decays to zero as one moves away from the oscillating plate. For larger values of δ (corresponding to, e.g., a high frequency oscillation of the plate) the flow is dominated by inertial effects and the perturbation to the flow field is restricted to a shallow layer near the moving plate -- the fluid's inertia wants to keep the fluid at rest. For smaller values of δ (corresponding to low frequency oscillations or large viscosity) viscous effects dominate and the velocity perturbation caused by the moving plate is felt further inside the bulk of the fluid -- due to the large viscosity, the plate can drag 'more' fluid with it. Therefore the velocity perturbation decays more slowly as one moves away from the plate.



Page last modified: October 22, 2001

Back to Matthias Heil's home page..

The URL of this page is:
http://www.maths.man.ac.uk/~mheil/Lectures/Fluids/OscillatingPlateAnimation.html