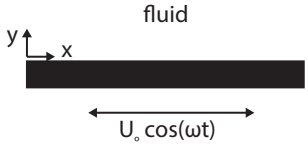
ME 106 Project 2

Due Date: December 1, 2017

In this project you will be solving a classic fluid mechanics problems, the oscillating plate. Include a print out of your code (with comments). In addition, submit a typed write-up explaining your work, which should include derivations for equations used in your code, plots asked for in the assignment, an explanation on how the numerical code works, an explanation for any assumptions and boundary conditions used, and the physical significance of your solution, e.g. why does your plot take this form. You may use any program you are comfortable with (Matlab, Python, FORTRAN, C/C++, Java, IDL, etc).

Oscillating Plate

In this problem consider an infinite plate which moves in sinusoidal periodic motion with a velocity, $U_o \cos(\omega t)$, parallel to itself, as shown in the image. Where, $U_o = 1 \ \frac{m}{s}$ and $\omega = 500 \ \frac{1}{s}$. A viscous fluid is above the plate starting at $y = 0$ to $y \longrightarrow \infty$, where $\nu = 16.1 \ \frac{m}{s^2}$. Consider the solution after all transient effects have died, i.e. the plate has been oscillating forever. Note this does not mean it's steady. Although the motion takes the form $U_o \cos(\omega t)$, assume the periodic motion takes the form $U_o e^{i\omega t}$ and then take the real part at the end of the problem when finding the solution for part a. Analyze this flow for $0 \leq y \leq 2$ and $0 \leq t \leq 4$.



(a) Derive the solution from the complete Navier-Stokes equation, i.e. solve for the velocity field.
(b) Define a characteristic velocity and length scale for this problem and non-dimensionalize the final answer. Explain the physical significance of your non-dimensional length scale.
(c) Plot the non-dimensional velocity versus the non-dimensional height from the plate for 5 different times, t. Where, the non-dimensional velocity is on the x-axis of your plot, and the non-dimensional height is on the y-axis of your plot.