Problem 267B

This assignment is a continuation of the preceding Problem 267A.

Using the problem preparation developed in answer to the preceding question, compute using Rayleigh's equation the non-dimensional amplification rate and the non-dimensional disturbance wavelength for a range of values of the governing parameters.

I suggest using complex numbers and using, for example, a Runge-Kutta integration scheme to integrate to find $f(y)$ starting at the wall, $y = 0$, where $f(0) = 0$ and $f'(0) = 0$. Then use an iteration scheme that continuously corrects the value of k until the boundary condition far from the wall is satisfied.

Please note: Since this could be an excessively long assignment for some, I would like you to spend no more than 3 hours on it. The assignment will be marked on the basis of the correctness of your progress after 3 hours and not on the accuracy of your answers (and not even on whether you get numerical answers). But please document your work in detail.

Using reference material (for example Schlichting's book "Boundary Layer theory" or Sherman's book "Viscous flow") prepare an appropriate replacement for the previous Problem 227. The challenge is how to evaluate the spatial stability characteristics (real frequency, ω, and complex wavenumber, k) for the boundary layer profile in Problem 226 using the Rayleigh equation.

- Develop a correct statement of the eigenvalue problem complete with boundary conditions.
- What particular feature of the boundary layer profile (given in Problem 226) would lead you to believe that it is unstable?
- Discuss possible difficulties that might be experienced in trying to obtain numerical solutions of the stability problem.