Department of Mathematics and Statistics Colloquium

An eigenvalue search method using the Orr-Sommerfeld equation for shear flow

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Abstract: A physically-based computational technique was investigated which is intended to estimate an initial guess for complex values of the wavenumber of a disturbance leading to the solution of the fourth-order Orr-Sommerfeld (O-S) equation. The complex wavenumbers, or eigenvalues, were associated with the stability characteristics of a semi-infinite shear flow represented by a hyperbolic-tangent function. This study was devoted to the examination of unstable flow assuming a spatially growing disturbance and is predicated on the fact that flow instability is correlated with elevated levels of perturbation kinetic energy per unit mass. A MATLAB computer program was developed such that the computational domain was selected to be in quadrant IV, where the real part of the wavenumber is positive and the imaginary part is negative to establish the conditions for unstable flow. For a given Reynolds number and disturbance wave speed, the perturbation kinetic energy per unit mass was computed at various node points in the selected subdomain of the complex plane. The initial guess for the complex wavenumber to start the solution process was assumed to be associated with the highest calculated perturbation kinetic energy per unit mass. Once the initial guess had been approximated, it was used to obtain the solution to the O-S equation by performing a Runge-Kutta integration scheme that computationally marched from the far field region in the shear layer down to the lower solid boundary. Results compared favorably with the stability characteristics obtained from an earlier study for semi-infinite Blasius flow over a flat boundary.

Monday, November 4 at 3:45 in Roop 103

refreshments at 3:30