

ABSTRACT

Study of Laminar-Turbulent Transition on Two-Dimensional Suction Boundary
Layer

by

Lutfi Muzzaki Khairullah

Dr. Eng. Ressa Octavianty, Advisor
Triwanto Simanjuntak, PhD, Co-Advisor

In this thesis, the temporal stability of two-dimensional asymptotic suction flow was studied at wide-range of Reynolds number. Linear stability with small disturbances were introduced to Navier-Stokes equations in viscous boundary layer flow, in the form of Orr-Sommerfeld equation. Here, the compressibility effect was neglected in the assumption. A spectral collocation method was used to solve the fourth-order ordinary differential equation (ODE) of generalized eigenvalues problem. MATLAB and Python softwares were used to perform the numerical calculation. Moreover, this thesis benefits the highly accurate and widely used open-source function-based numerical computing system, i.e. Chebfun. Two variables were varied, Reynolds number Re and wavenumber α to investigate the temporal growth of disturbances in this flow. Note that in this study, Reynolds number was from 10^3 to 10^8 , and α was in the range of 0.01 to 0.30. It was found that both variables indeed affect the temporal stability where the flow is stable for all alphas at $Re <$ than Re critical ($Re_{crit} = 48\,000$). It should be noted also that for wide range of Reynolds numbers, no temporal growth appeared at $\alpha > 0.19$. In addition, the highest growth was observed at $198\,155 < Re < 500\,566$, for all wavenumbers within range of 0.1 – 0.12. With the limitaton of machine and high computational cost, the accuracy of the results is in order of $\mathcal{O}(10^3)$ for the Reynolds number and $\mathcal{O}(10^{-2})$ for the wavenumber α .

Keyword: *Orr-Sommerfeld Equation, Boundary Layer, Spectral Collocation Method, Stability, Transition, Laminar, Turbulent, Suction*