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STABILITY ANALYSIS OF FLUID FLOW THROUGH POROUS MEDIA

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Fluid flow through porous media occurs in many industrial, geophysical, and biochemical applications, such as filtration and biological tissues. In this study, the stability of the viscous fluid flow through 2D cylindrical porous media is studied. The steady Darcy-Brinkman equation as the governing equation is used to describe the fluid flow through the porous media. There are many methods that we can use for stability analysis. Galerkin approximation and the Homotopy perturbation method are some of them. By considering the accuracy of the method, under this study, the modal stability analysis is performed using the 2D Orr-Sommerfeld derivation method. Due to the efficiency and accuracy, the Chebyshev collocation method is used to solve the boundary value problem. In the Chebyshev collocation method, small disturbances to the velocity potential are applied. Then the equations are expanded in terms of Chebyshev polynomials. By doing a stability analysis, we can determine whether the flow is stable or unstable. The stability analysis was done using the eigenvalue analysis. The most unstable eigenvalues for the fluid flow through the 2D porous cylinder are used to obtain the stable or unstable flow conditions at various Reynolds numbers and for various wave numbers. Conclusions are obtained as follows; if the eigenvalue has a negative imaginary part that indicates the base flow is stable, if there exists one eigenvalue with a positive imaginary part that indicates the base flow is unstable. The base flow is stable or unstable when the largest imaginary part of the eigenvalue equals zero. It is shown that the stability of the flow field depends on the parameters, such as wave number and Reynolds number. Future work will be focused on determining the stability conditions for the free flow over porous media.

Keywords: Chebyshev collocation method, Darcy-Brinkman equation, Orr-Sommerfeld derivation method, Porous media.