University of Glasgow

School of Mathematics and Statistics

Level-5 Honours project

Hydrodynamic Stability

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Declaration of Originality
I confirm that this assignment is my own work and that I have:

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- *Fully referenced (including page numbers) and used inverted commas for all text quoted from books, journals, web etc.*
- *Provided the sources for all tables, figures, data etc. that are not my own work.*
- *Not made use of the work of any other student(s) past or present without acknowledgement. This includes any of my own work, that has been previously, or concurrently, submitted for assessment, either at this or any other educational institution, including school.*
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I also agree that this project can be used by the School of Mathematics and Statistics at University of Glasgow for teaching, recruitment and other aspects of its work.

Monday 14th September, 2015

Abstract

The text for your abstract goes here. Abstracts should be a SHORT but COMPLETE summary of what you have accomplished.

We have considered the stability of flow in flexible-walled channel....

Contents

1 Introduction

Introductory text goes here. Use references where appropriate, which can be included using the `cite` *command*

A viscous liquid flowing through a rigid channel driven by a constant pressure gradient can become unstable to small perturbations when the Reynolds number of the flow is sufficiently large [1]. However, Benjamin [2] showed that this instability threshold is significantly modified when one of the channel walls is compliant.

The final report should be restricted to 50 pages **maximum** *excluding the title page, abstract, table of contents and references. Reports exceeding or adjusting the set format will be penalised.*

The introduction should also set out how the report is structured.

In Sec. 2 we consider the stability of flow in a rigid channel. In a similar manner, we consider the stability of flow in a rigid pipe in Sec. 3.

2 Stability of Poiseuille flow in a rigid channel

Equations can be included in the main text using the `eqnarray` *environment. These should be included with proper punctuation. When using variables in the main text these should be placed inside dollar signs to ensure they are displayed in math mode.*

We consider the motion of a incompressible Newtonian fluid of density ρ and viscosity μ in a two-dimensional rigid channel of width $2a$, where x is the displacement along the channel, y is the transverse distance from the centreline (so the channel walls lie at $y = \pm a$) and t is time. Denoting U_0 as a typical flow speed in the channel, we scale displacements on a, velocities on U_0, time on a/U_0 and pressure on ρU_0^2. The Navier-Stokes equations governing viscous fluid motion take the form

$$\nabla \cdot \mathbf{u} = 0, \qquad \mathbf{u}_t + (\mathbf{u} \cdot \nabla)\mathbf{u} = -\nabla p + R^{-1}\nabla^2 \mathbf{u}, \tag{2.1}$$

where $\mathbf{u} = (u, v)$ is the nondimensional velocity field, p is pressure and subscripts denote derivatives.

Figures should be embedded directly into the text. Figures should be saved in the same directory where you have saved the .tex document. The most common format when is to use .jpg and .png figures. All figures should be referenced directly in the main text.

As shown in Fig. 1 ...

2.1 Subsection title

Use of subsections can make reports significantly easier to read.

3 Stability of Poiseuille flow in a rigid pipe

Other sections of the report can be referenced using the `ref` *command.*

In a similar to manner to Sec. 2, we now consider the stability of Poiseuille flow in a rigid pipe.

4 Discussion

A Appendix title

Material suitable for appendices goes here.

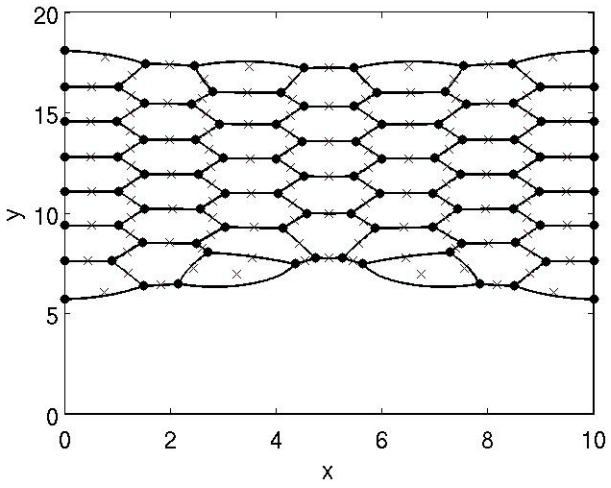

Figure 1: Caption content goes here.

References

[1] P. G. Drazin and W. H. Reid, Hydrodynamic Stability, Cambridge University Press, (1981).

[2] T. B. Benjamin, Effects of a flexible boundary on hydrodynamic stability, *Journal of Fluid Mechanics* **9**, 513-532 (1960).