Department of Mathematical Sciences

TMA4500 - Industrial Mathematics, Specialization Project

Optimization using second order information on the Symplectic Stiefel manifold

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1 Introduction

Hi! Welcome to this LaTeX-template. I will here aim to introduce you to, as well as motivate you to learn more about the features available in LaTeX through Overleaf. Many of the features you will come across in this template are not necessarily relevant to you at this point in time, and some will most likely seem way too advanced. However, keep in mind that you are not expected to understand everything at once either.

I hope that you, with the assistance of what I provide you with here, are able to make your own LaTeX-templates containing your personal preferences. You may do it by directly changing variables in this template, or you may create a brand new containing only carefully selected features of your own.

As a final note, I want to wish you the best of luck learning LaTeX, but do keep in mind that this template is only scratching the surface.

2 Example Section

In physics, the Navier–Stokes equations, named after Claude-Louis Navier and George Gabriel Stokes, describe the motion of viscous fluid substances.

(1) shows the incompressible Navier-Stokes equations using tensor notation.

$$\frac{\partial u_i}{\partial t} + u_j \frac{\partial u_i}{\partial x_j} = -\frac{1}{\rho}\frac{\partial P}{\partial x_i} + \nu \frac{\partial^2 u_i}{\partial x_j^2} \tag{1}$$

Figure 1: Caption written below figure.

Source: Insert image source here

3 Theory

3.1 Basic definitions

Definition 1 (Smooth manifold)**.** *Given a topological space $\mathcal{M}$, it is a topological manifold of dimension n if*

1. *$\mathcal{M}$ is a Hausdorff space: for every pair of $p, q \in \mathcal{M}$, we can always find to disjoint subsets of $\mathcal{M}$, U and V, such that $p \in U$ and $q \in V$.*
2. *$\mathcal{M}$ is second-countable: the topology of $\mathcal{M}$ has a countable basis.*

3. *$\mathcal{M}$ is locally Euclidean of dimension n: for each p we have an open subset $U \subseteq \mathcal{M}$ containing p, and an open subset $\hat{U} \in \mathbb{R}^n$ such that there exists a homeomorphism $\phi : U \to \hat{U}$.*

If we in addition have a notion of smoothness, meaning that the notion of differentiability is well-defined, we call $\mathcal{M}$ a smooth manifold.

For the rest of this paper we denote $\mathcal{M}$ as being a Riemannian manifold.

4 Conclusion

But the fact that some geniuses were laughed at does not imply that all who are laughed at are geniuses. They laughed at Columbus, they laughed at Fulton, they laughed at the Wright Brothers. But they also laughed at Bozo the Clown - Sagan (1993).

Bibliography

Ghia, U., K. N. Ghia and C. T. Shin (1982). 'High-Re Solutions for Incompressible Flow Using the Navier-Stokes Equations and a Multigrid Method'. In: *Journal of Computational Physics* 48, pp. 387–411.

NTNU, Department of Marine Technology (2020). *IMT Software Wiki - LaTeX*. URL: https://www.ntnu.no/wiki/display/imtsoftware/LaTeX (visited on 15th Sept. 2020).

Sagan, Carl (1993). *Brocas brain: reflections on the romance of science*. Presidio Press.

Appendix

A Hello World Example

```cpp
int main {
    // This is a comment
    std::cout << "Hello World from C++!" << std::endl;
    std::cout << "I am using the default style to print this code in beautiful
    ↪  colors. Since the text is so long I have to include the 'breaklines'
    ↪  option as well" << std::endl;
    return 0;
}
```

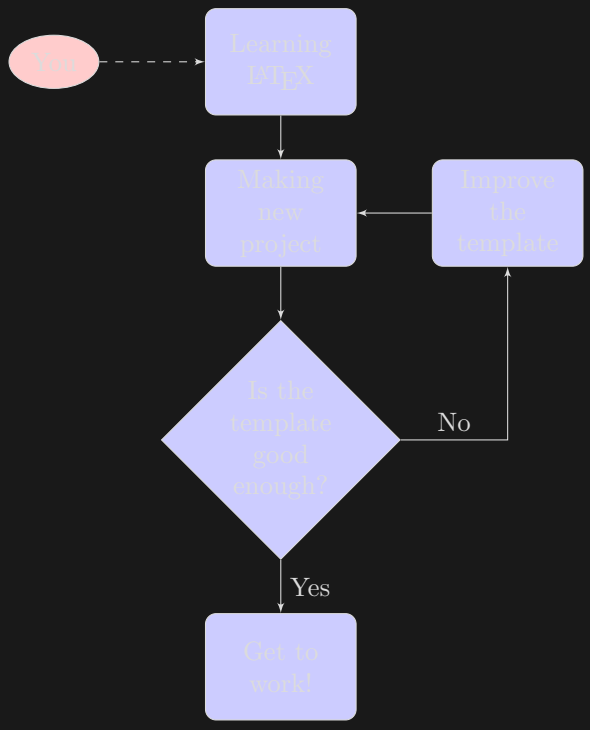
⋮

```python
# This is a comment
print('Hello world from Python!')
print('I am using the "rrt" style to print this code in beautiful colors')
```

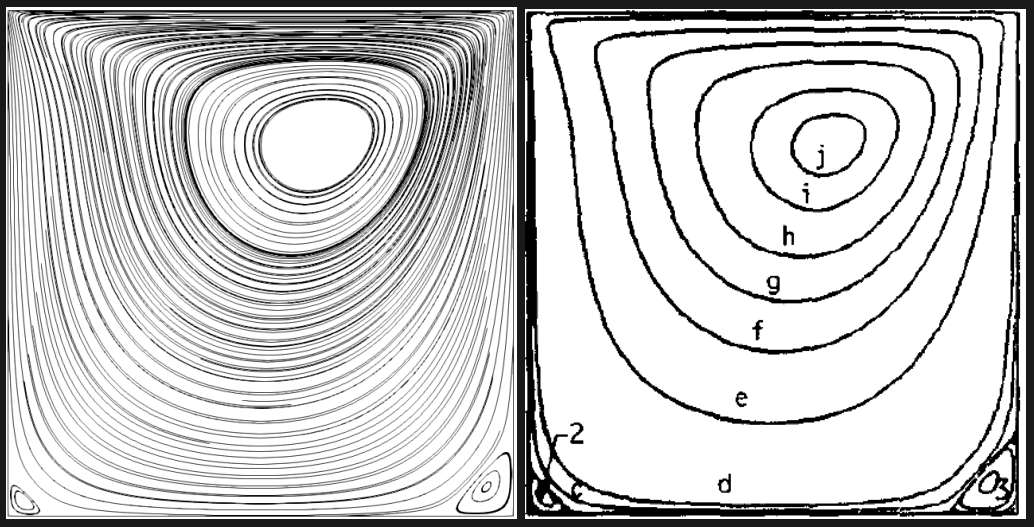
⋮

```matlab
% This is a comment
disp("Hello World from MATLAB!");
disp("I am using the "tango" style to print this code in beautiful colors");
```

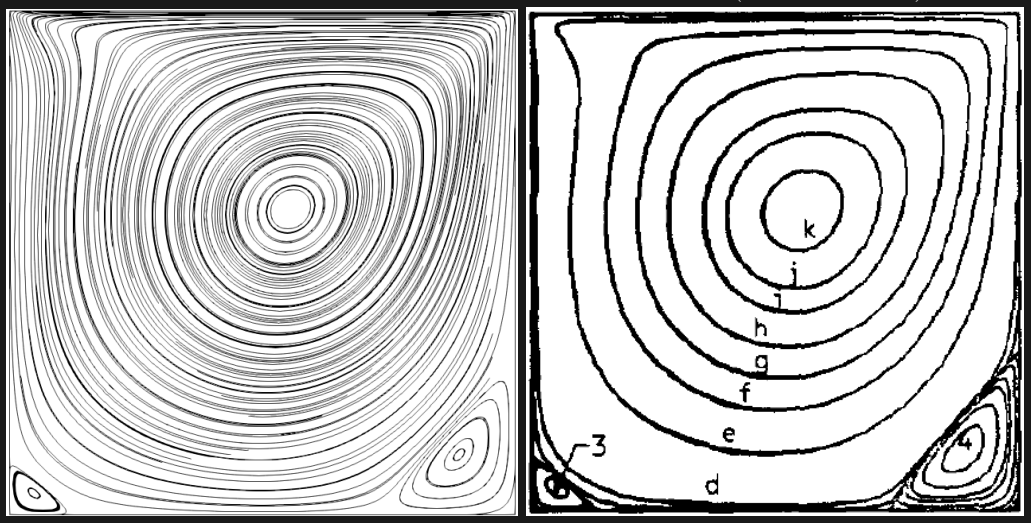
B Flow Chart Example



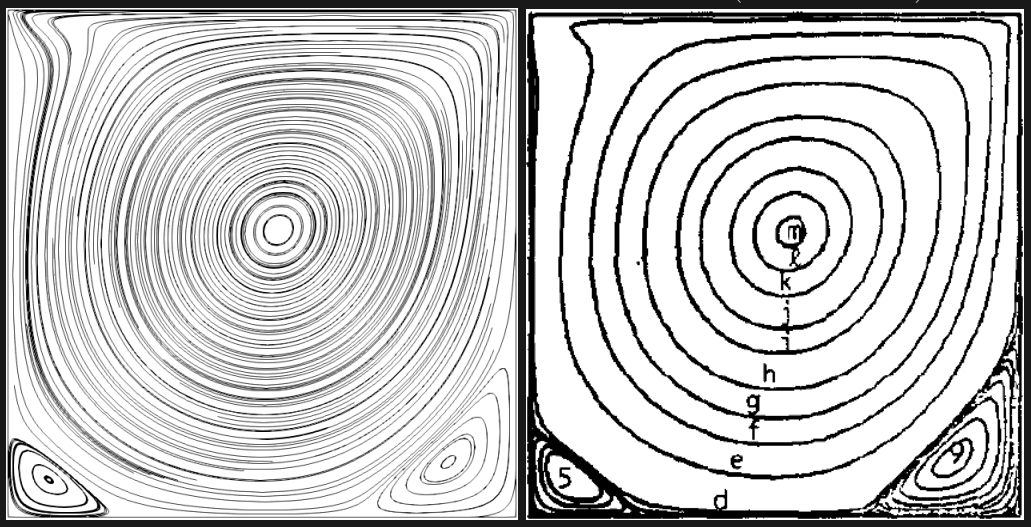
C Sub-figures Example



$Re = 100$ - Exercise $Re = 100$ (Ghia et al. 1982)



$Re = 400$ - Exercise $Re = 400$ (Ghia et al. 1982)



$Re = 1000$ - Exercise $Re = 1000$ (Ghia et al. 1982)

Figure 2: Streamlines for the problem of a lid-driven cavity.