

# Project 2

For the course FYS3150

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## 1 Abstract

## 2 Introduction

All programs are found at our [GitHub-repository](#).

## 3 Method

### 3.1 Exercise a)

In this exercise we are going to prove that  $\vec{w}_i = U\vec{v}_i$  is an orthogonal or unitary transformation that preserves the dot product and orthogonality. We start by multiplying  $\vec{w}_j^T$  with  $\vec{w}_i$  to take the vector product, also called the dot product. If the vector product of these vectors is equal to  $\delta_{ij}$ , given by  $\vec{v}_j^T \vec{v}_i = \delta_{ij}$  in the exercise, then the dot product and orthogonality is preserved. In this exercise we assume that  $U^T U = I$ , where  $I$  is the identity matrix, because this defines a unitary matrix  $U$  which we compute with in this exercise.

The vector product is calculated as followed:

$$\begin{aligned}\vec{w}_j^T \vec{w}_i &= (U\vec{v})^T U\vec{v}_i \\ &= \vec{v}_j^T U^T U \vec{v}_i \\ &= \vec{v}_j^T \vec{v}_i \\ &= \delta_{ij}\end{aligned}$$

The vector product of  $\vec{w}_j^T$  and  $\vec{w}_i$  is  $\delta_{ij}$ , which proves that the dot product and orthogonality is preserved for the transformation.

### 3.2 Exercise b)

#### 3.2.1 Calculations

Det under som ikke er mulig å lese blir kommentert ut:

Ferdig kommentert ut.

#### 3.2.2 The programming

### 3.3 Exercise c)

#### 3.3.1 Calculations

#### 3.3.2 The programming

### 3.4 Exercise d)

#### 3.4.1 Calculations

#### 3.4.2 The programming

### 3.5 Exercise e)

#### 3.5.1 Calculations

#### 3.5.2 The programming

## 4 Results and discussion

Our results are as shown in the [Appendix](#). We also have .txt-files for all the raw data generated by the projects up on [GitHub](#).

### 4.1 Exercise a)

### 4.2 Exercise b)

### 4.3 Exercise c)

### 4.4 Exercise d)

### 4.5 Exercise e)

## 5 Conclusion and perspective

## 6 Appendix

## 7 References

[Link to the PDF for Project 2.](#)

[Our GitHub-repository.](#)

[Link to lecture slides in FYS3150 - Computational Physics.](#)