-The main goal of this thesis is to describe certain numerical integration methods, together with their properties and solutions. There will also be some Matlab code examples as well as real-world applications of these topics. This bachelor’s thesis was motivated by the practicality of numerical integration methods in our daily lives. This topic has a wide range of applications in physics, mathematics, chemistry, and computer science.

The methods are used to identify irregularly shaped areas. Petronas buildings located in Malaysia were designed using integration methods to make them stronger. Finding volumes of wine barrels was one of the early applications of integration.

All the examples presented below are created by me except for the last one.

-Differentiation is a method of finding the derivative of a function. Mathematicians use a procedure called differentiation to determine a function's instantaneous rate of change based on one of its variables. Using the optimal value for h gives us minimal error. This formula is known as the forward-difference formula if h > 0 and the backward-difference formula if h < 0.

Example: In this exercise we use the forward difference formula for the function 1/x and x0=2,3.

We can also calculate a bound for the approximation error. We can conclude that 0.02 is more suitable as h value than the other two.

-We introduce the weighted mean value here because we'll utilize it later.

We need a continuous function f on [a,b], a Riemann integrable function g on [a,b] that does not change its sign(A bounded function on a compact(bounded and closed) interval [a, b] is Riemann integrable if and only if it is continuous almost everywhere)

Example: We have the function 1+x^2 on the interval [-1,2]. We apply the Weighted Mean Value Theorem.

The function f is a continuous function on that interval because we have a sum of elementary functions. We apply the definition for g(x)≡1(identical to 1).

The average value of the function is 21/3 and c =21/6.

-Simpson's rule is a method of numerical integration which is more accurate than the Trapezoidal rule. We want to compare the two methods of approximation.

Example: We use the approximation methods for the function x^3 on the interval [1,3] without the errors, that's why we have approximately equal and not equal.

We get 28 for the Trapezoidal approximation and 20 for Simpson which is the exact value of the integral. Our hypothesis comes true, Simpson's being more accurate.

-Composite rules are applied on subintervals. We have n+1 numbers x0 being the first one and xn being the last one. It is like an arithmetic progression with ratio h. That's why h=(b-a)/n, b being the last element and a the first one.

-The difference between the composite trapezoidal rule and the trapezoidal rule is that in the composite one the interval [a,b] is divided into n parts, each value of each point in the interval being added to the sum. At the error of the composite rule we will subtract n terms.

Example: We have the function 5\*x\*e^(-2\*x) and three segments should be used so n=3. So we calculate h, we give common factor 1/2 and substitute everything and we'll get 0.38. At the point b we’ll do an integration by parts to get our exact value of the integral. The error is the difference between approximation and exact value.

-The Composite Simpson Rule and The Simpson Rule are similar as well except for the fact that at the Composite one we have n terms and each value of each term will be added to the sum. The coefficient will be 4 if it the coefficient is an odd number and 2 if it is an even one.

-The Closed Newton Cotes chapter is more to present what kind of methods are part of the closed ones, the trapezoidal method being already presented.

-For the Open Newton Cotes with n=0 we have the Midpoint Rule. Here x\_{-1} is a and x\_{n+1} is b and x\_{0} is the middle of the interval. h = (b-a)/(n+2) probably because we add the term x\_{-1} and x\_{n+1}.

-We have the adaptive Quadrature which uses Simpson's Rule multiple times. Basically we have to compare the two absolute values and we conclude that they are very similar.

-And for the last part I chose a real life application with Matlab code, more precisely the calculation of an ellipsoidal surface. We have an ellipsoid because we rotate the ellipse around the x axis. We have the equation of the radius, certain values for alpha and beta and an integral.

Syms lists the names of all symbolic scalar variables, functions, and arrays in the MATLAB workspace. Sym is a symbolic variable. vpa is used for the number of decimals.

For the last part we have 4 numerical integration methods compared based on approximation error. The 4\*pi\*alpha is the common part to all 4. The integral is different. Romberg has the biggest error so it's the worst in this case.