Object-oriented Modelling and Programming in Engineering

Homework 1

1. Problem

From an oscillating energy system you've got the equation for the power:

$$P(t) = a_1 * sin^2(2 * \pi * f_1 * t) + a_2 * \cos^2(2 * \pi * f_2 * t + 0.1\pi)$$

Whereat:

$$a_1 = 2\,W$$

$$a_2 = 1.5\,W$$

$$f_1 = 2\,Hz$$

$$f_2 = \frac{[Your\ registration\ number]}{40\,000}$$

For this system you want to calculate the energy consumption E(t) for t=20 seconds.

$$E(t) = \int_0^t P(t)dt$$

2. Hand in

<u>Hand in is only accepted via moodle with the file formats .pdf and .java</u>.

Hand in the following elements:

A .pdf-document with the following content:

- Exact **<u>result</u>** (not the calculation process) of the integration (see 3.2)
- Plot of the function P(t) (see 3.1)
- Nassi-Schneiderman diagrams for all three algorithms stated in 3.3
- UML-diagram(s) for the software structure
- Results of the numerical integration
- Visualization of the integral according to figure 1, 2, and 3 (blue area)
- Absolut and relative error of the numerical results

And your source code (Remember to **<u>send all</u>** files – especially if you used a class from a seminar or lecture):

- Java class(es) with implementation
    - Calculating the numerical integral
    - Plot original function
    - Calculate absolut and relative error in relation to the manual calculated integral
- Java class(es) for testing

3. Tasks

3.1 Calculating grid points and plot

Calculate at least 10 grid points per second and plot the function in the range of 20 seconds.

3.2 Calculating the analytical integral

Calculate the analytical integral by hand.

3.3 Calculate the numerical integral

Calculate the numerical integral with the 3 methods listed below. Use the calculated grid points only for the calculation:

1. Take the value, y_0, of gridpoint $[x_0,y_0]$ as height for the area between x_0 and x_1 (see figure 1)
2. Take the mean value from y_0 and y_1 as value for the area between x_0 and x_1 (see figure 2)
3. Linear interpolation between two consecutive points (see figure 3)

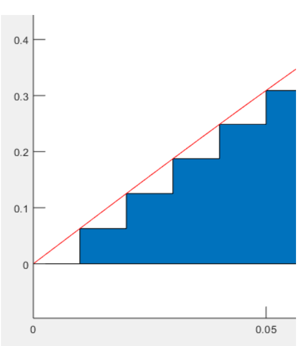

figure 1: y_0 as value (1)

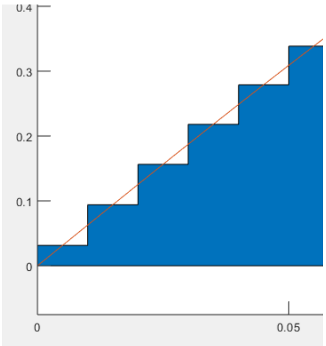

figure 2: Average as value (2)

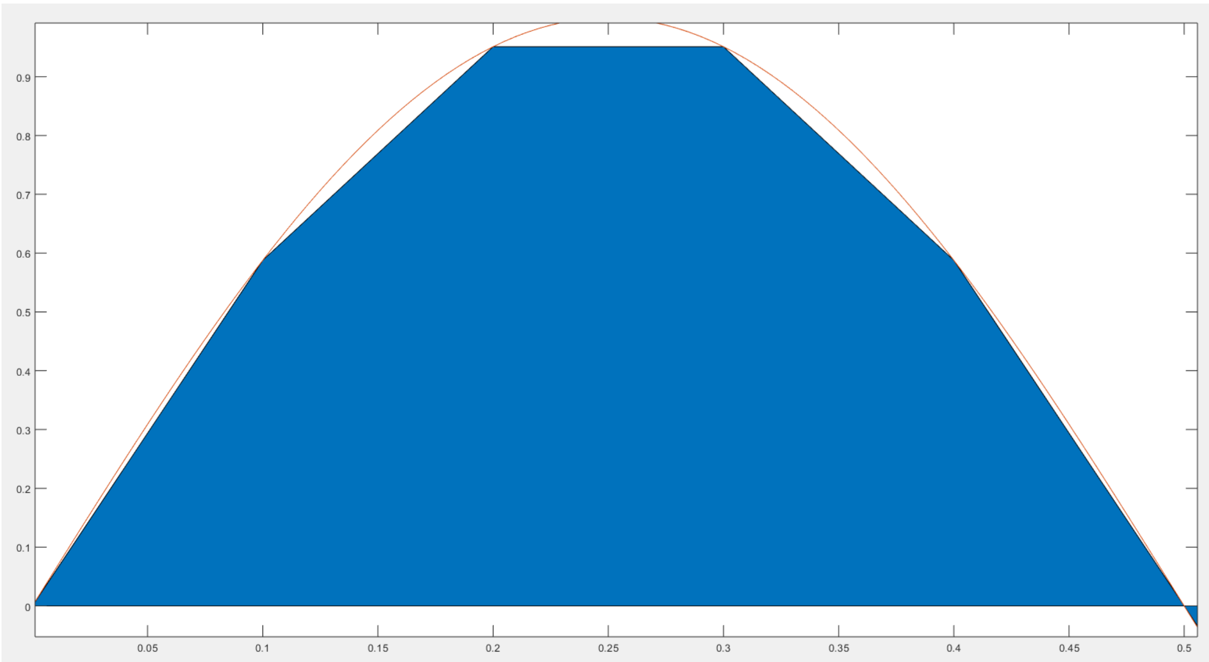

figure 3: Linear Interpolation between points for integration