A primer in Mathematics – Assignment 1

Exercise 1.1 — Credit for a photovoltaic power plant.

The cost for a photovoltaic power plant is C = 20000 EUR. A PV enthusiast only has 5000 EUR available and requires a credit from the bank to finance the project. The bank offers him an annual interest rate of $i = 4\%$.

Please give a formulaic expression for the increase of the debt with time t assuming the credit was granted at $t = 0$. Hint: Recursively write the expressions for the first few years and suggest an explicit expression. How large would be the debt after 10 years?

Give the expression for the growth of debt also in terms of Euler's number.

Give the characteristic quantities: lifetime $\tau = 1/\lambda$ and the doubling time T_2. What is the general relationship between λ and T_2.

Exercise 1.2 — Distribution of wind velocities.

The histogram of wind velocities u recorded over a year often follows the Weibull-distribution:

$$f(u) = \frac{k}{A}\left(\frac{u}{A}\right)^{k-1} e^{-\left(\frac{u}{A}\right)^k}$$

with the two Weibull parameters A and k which characterize the whole curve. In other words, it is sufficient to look at just these two parameters in order to compare the wind conditions at different locations. It is therefore necessary to determine A and k from our measurement data.

Without going into too much detail this is achieved using the integral $F(u)$ of the histogram (i.e. the accumulated wind velocities) which is described by: $F(u) = 1 - e^{-\left(\frac{u}{A}\right)^k}$

Using the methods from this section transform this equation into a linear form and give expressions for A and k.

Table 1 gives the normalized data for a wind velocity histogram. Calculate A and k.

wind velocity (m/s)	1	2	3	4	5	6	7	8	9	0	11	12	13	14	15	16	17	18
elative frequency (%)	1	2	5	7	9	11	11	11	9	8	6	6	5	3	2	2	1	1

Table 1: Wind velocities