

Assignment 3: Curve Fitting

1. An object covers a distance d in time t . A measurement of d with respect to t produces the set of values given in Table I.

t (s)	1	2	3	4	5	6	7	8
d (m)	0.20	0.43	0.81	1.57	2.43	3.81	4.80	6.39

TABLE I: Measurements of distance as a function of time.

Plot the distance with respect to t . Then plot with respect to t^2 . If the object was initially at rest, calculate the acceleration. Use curve fitting.

2. Biomedical instruments are used to measure many quantities such as body temperature, blood oxygen level, heart rate and so on. Engineers developing these devices often need a response curve that describes how fast the instrument can make measurements. The response voltage v can be described by one of these equations,

$$\begin{aligned}
 v(t) &= a_1 + a_2 e^{-3t/T} \\
 v(t) &= a_1 + a_2 e^{-3t/T} + a_3 t e^{-3t/T}
 \end{aligned}
 \tag{1}$$

where t is the time and T is an unknown constant. The data given in Table II gives the voltage v of a certain device as a function of time. Which of the above functions is a better description of the data?

t (s)	0	0.3	0.8	1.1	1.6	2.3	3
v (V)	0	0.6	1.28	1.5	1.7	1.75	1.8

TABLE II: Response of a biomedical instrument switched on at time $t = 0$.

3. When a constant voltage was applied to a certain motor initially at rest, its rotational speed $S(t)$ versus time was measured. The table given below shows the values of speed against time.

Time (s)	1	2	3	4	5	6	7	8	10
Speed (rpm)	1210	1866	2301	2564	2724	2881	2879	2915	3010

TABLE III: Motor speed when it is given a push.

Try to fit the given data with the function given below. Calculate the constants b and c.

$$S(t) = b(1 - e^{ct}) \quad (2)$$

4. The yield stress of many metals, σ_y , varies with the size of the grains. Often, the relationship between the grain size, d, and the yield stress is modelled with the Hall-Petch equation,

$$\sigma_y = \sigma_0 + kd^{-1/2} \quad (3)$$

d (mm)	0.006	0.011	0.017	0.025	0.039	0.060	0.081	0.105
σ_y (MPa)	334	276	249	235	216	197	194	182

TABLE IV: Measurement of flow velocity.

Determine the constants and best fit the data points.