جَامعة
المَنارة
MANARA UNIVERSITY

Example

The force-deflection data for the cantilever beam is given in the following table.

Force f (lb)	0	100	200	300	400	500	600	700	800
Deflection x (in.)	0	0.15	0.23	0.35	0.37	0.5	0.57	0.68	0.77

Use MATLAB to obtain a linear relation between x and f, estimate the stiffness k of the beam, and evaluate the quality of the fit.

Use MATLAB to fit a straight line to the beam force-deflection data given , but constrain the line to pass through the origin.

Example

Water in a glass measuring cup was allowed to cool after being heated to 204°F. The ambient air temperature was 70°F. The measured water temperature at various times is given in the following table.

Time (sec)	0	120	240	360	480	600
Temperature (°F)	204	191	178	169	160	153

Time (sec)	720	840	960	1080	1200
Temperature (°F)	147	141	137	132	127

Obtain a functional description of the water temperature versus time.

INTEGRAL FORM OF THE LEAST-SQUARES CRITERION

Sometimes we must obtain a linear description of a process over a range of the independent variable so large that linearization is impractical. In such cases we can apply the least-squares method to obtain the linear description. Because there are no data in such cases, we use the integral form of the least-squares criterion.

Example

a. Fit the linear function $y = mx$ to the power function $y = ax^n$ over the range $0 \le x \le L$. The values of a and n are given.

b. Apply the result to the Aerobee drag function $D = 0.00056v^2$ over the range $0 \le v \le 1000$,

a. The appropriate least-squares criterion is the integral of the square of the difference between the linear model and the power function over the stated range. Thus,

$$J = \int_0^L (mx - ax^n)^2 \, dx$$

To obtain the value of m that minimizes J, we must solve $\partial J/\partial m = 0$.

$$\frac{\partial J}{\partial m} = 2 \int_0^L x(mx - ax^n) \, dx = 0$$

This gives

$$m = \frac{3a}{n+2} L^{n-1} \tag{1}$$

b. For the Aerobee drag function $D = 0.00056v^2$, $a = 0.00056$, $n = 2$, and $L = 1000$. Thus,

$$m = \frac{3(0.00056)}{2+2} 1000^{2-1} = 0.42$$

and the linear description is $D = 0.42v$, where D is in pounds and v is in ft/sec. This is the linear model that minimizes the integral of the squared error over $0 \le v \le 1000$ ft/sec.