Example 11

Exponential fit example using EXCEL

The given in the first two columns are the time (t, s) and the corresponding temperature excess (T, °C) over the ambient of a certain system. The data is expected to be well represented by an exponential law in the form $T = A\exp(-Bt)$. Obtain the fit using EXCEL.

EXCEL work sheet appears as below.

t (s)	Data, (T)	Fit,(T)	ln(T)	ln(T)	t^2	t ln(T)	$[\ln(T)]^2$
0.35	60	58.64	4.09	4.09	0.12	1.43	16.76
0.6	50	50.39	3.91	3.91	0.36	2.35	15.30
0.937	40	41.07	3.69	3.69	0.88	3.46	13.61
1.438	30	30.31	3.40	3.40	2.07	4.89	11.57
2.175	20	19.38	3.00	3.00	4.73	6.52	8.97
3.25	10	10.10	2.30	2.30	10.56	7.48	5.30
mean t, s				Mean of [ln(T)]	Var t	Covaria-nce	Var of ln(T)
1.45833				3.3991	0.9935	0.6026	0.3659
slope B, 1/s				intercept, ln A			
-0.607				4.2837			
τ,s				(T_o)=A, °C			
1.649				72.5			
				ρ			
t (s)	Data,(T)	Fit,(T)	Error	-0.9994			
0.35	60	58.64	1.36				
0.6	50	50.39	-0.39				
0.937	40	41.07	-1.07				
1.438	30	30.31	-0.31				
2.175	20	19.38	0.62				
3.25	10	10.10	-0.10				

It is noted that the data represents a linear law on the semi-log plot (the student is recommended to test this out by making a plot).

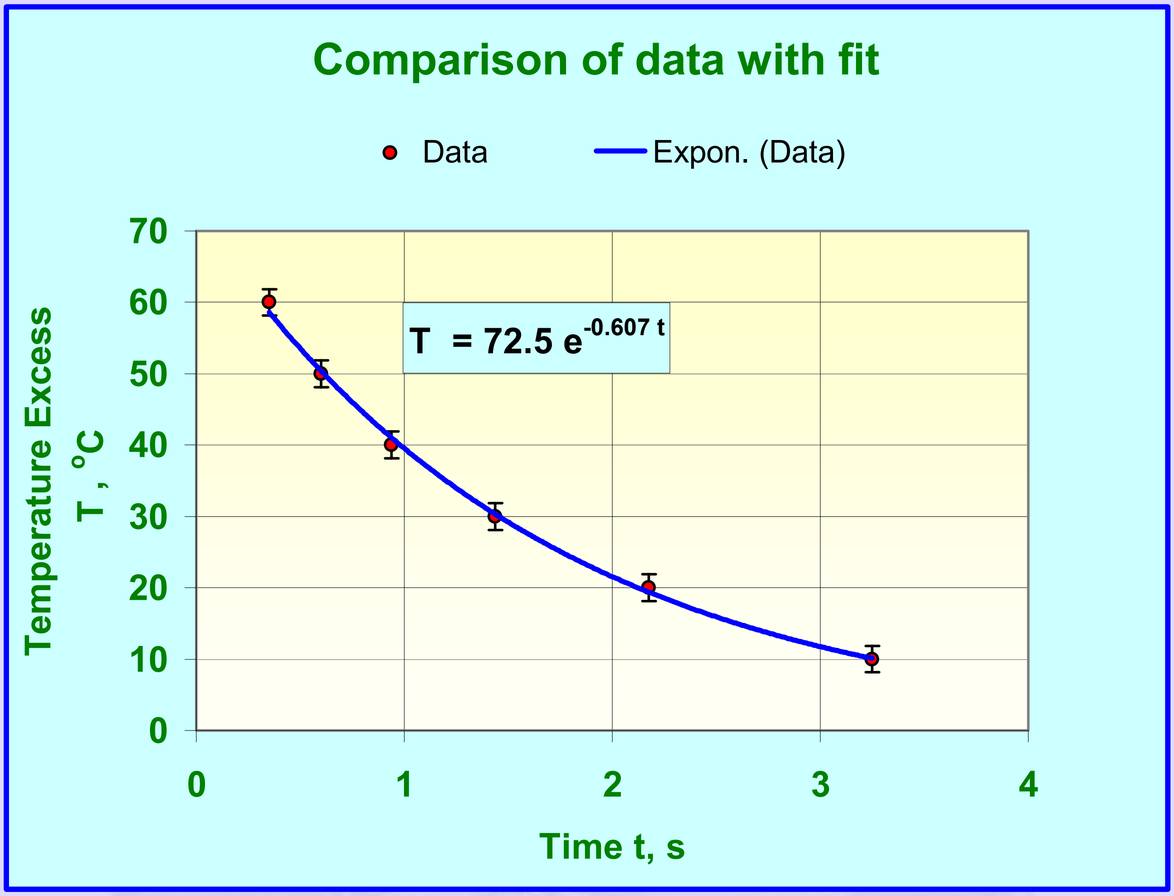

Figure 16 Comparison of data with fit

The plot shown as Figure 16 indicates that the fit represents the data very well. Error bars are indicated based on 95% confidence limits using the **feature** available in EXCEL.

The standard error is calculated by using the following tabulation using EXCEL.

t (s)	Data, T °C	Fit,T°C	Error, °C	Square of error (°C)^2
0.35	60	58.64	1.36	1.86
0.6	50	50.39	-0.39	0.15
0.937	40	41.07	-1.07	1.15
1.438	30	30.31	-0.31	0.10
2.175	20	19.38	0.62	0.38
3.25	10	10.10	-0.10	0.01
			Standard Error	1.87

Error bar indicated on T is based on the standard error of 1.87 indicated in the above table.

The problem may easily be solved by using the "Trend Line" option by choosing an **"exponential law"** from the menu.

The quality of the fit may also be gauged by comparing the data with the values obtained by the use of the exponential least square fit. This is done by making a **"parity plot"** as given below as Figure 17. The distribution of the data around the **"parity line"** is a measure of the goodness of the fit. The points should be close to the parity line and must be distributed **evenly** on the two sides if there is no **"bias"** in the measurement. It is observed that the exponential fit is good based on both these counts!

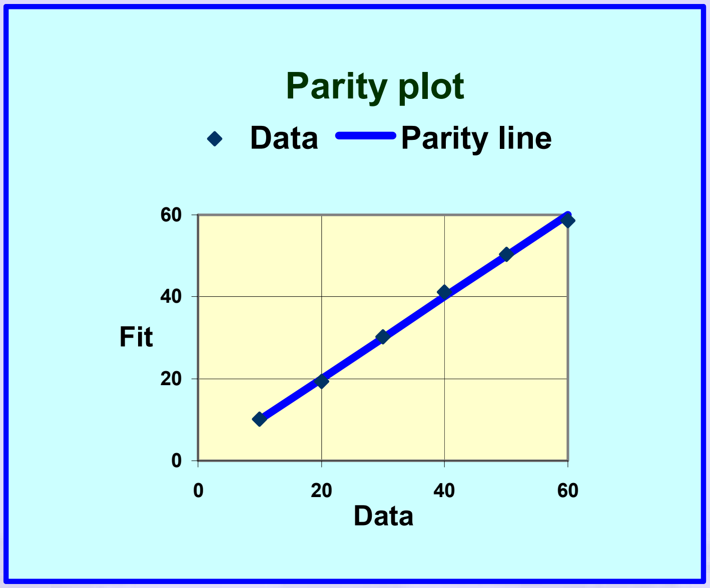

Figure 17 Parity plot for the exponential fit example.

Sometimes it is instructive to show the error between the data and the fit. In this example the error in the temperature excess between the **data and the fit** is plotted as a function of time as shown in Figure 18. The error is **evenly distributed** on both the positive and negative sides indicating absence of **bias**. The error between the data and the fit is no more than 1.5°C

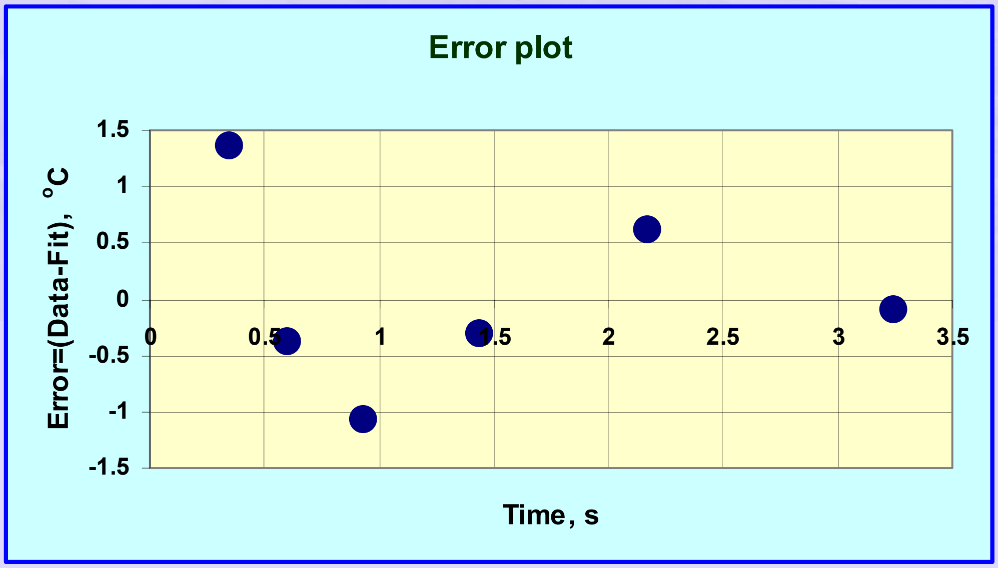

Figure 18 Error distribution plot for the exponential fit example.