



Instruction: Answer all the questions.

Question 1 [40 Marks]

The data generated from a set of experiments carried out on a system are given in the Excel worksheet named “data1” of the attached workbook named ‘odevbesdata’. The model of the system has been proposed to be of the type shown in Equation (1), where V (m^3) is the system volume, K_p (m^3) is the steady-state value, t (min) is the dynamic time, τ_d (min) is the delay time and τ_p (min) is the time constant of the system.

- (a) Write a MATLAB *mfile* program to estimate the model parameters (K_p , τ_p and τ_d) through:
- linearized regression using *regress* MATLAB command with K_p obtained by rounding up the last value of the experimental output (V) to one decimal place, and
 - nonlinear regression using *nlinfit* MATLAB command with 0.1 unit as the guess value for each of the parameters.

$$V = K_p \left(1 - e^{-\frac{(t-\tau_d)}{\tau_p}} \right) \quad (1)$$

- (b) Make the *mfile* program to be able to compare the outputs of the experiment with those of the linearized and the nonlinear regressions as shown in Figures 1 - 3.
- (c) Also, the program should be written to estimate the values of the performance criteria (sum of absolute errors (SAE), mean of absolute errors (MAE), sum of squared errors (SSE) and mean of squared errors (MSE)) and record those values into a worksheet, to be named ‘criteria’, of the workbook already named ‘odevbesdata’, which is containing the experimental data, as shown in Table 1.

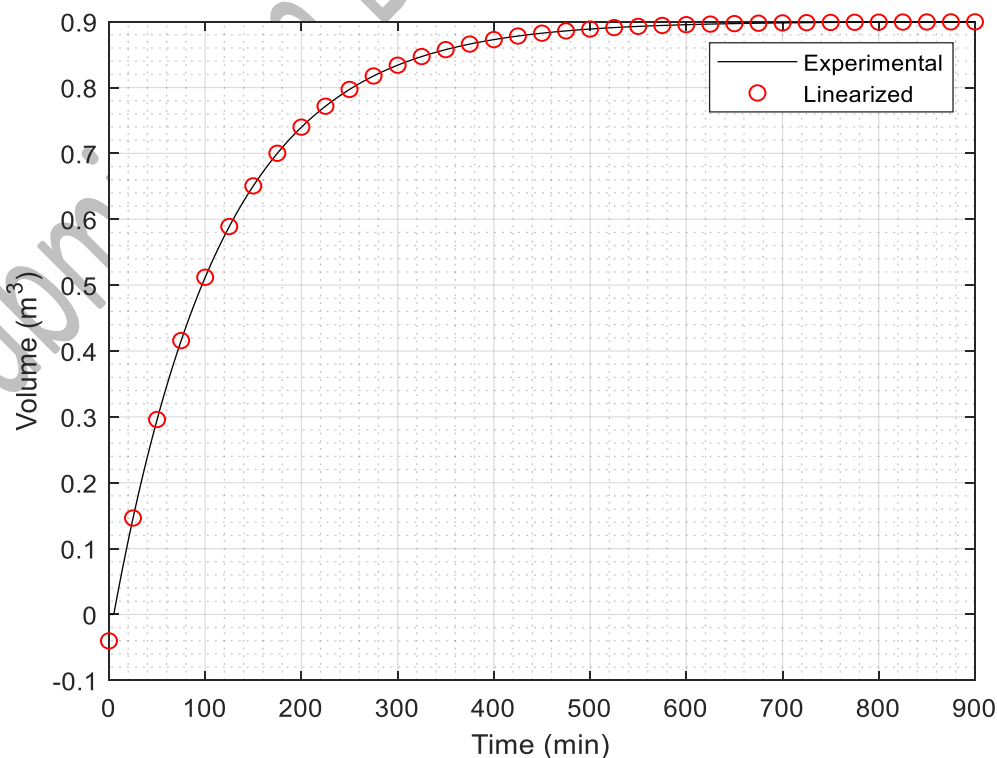


Figure 1: Comparison between experimental and linearized model data

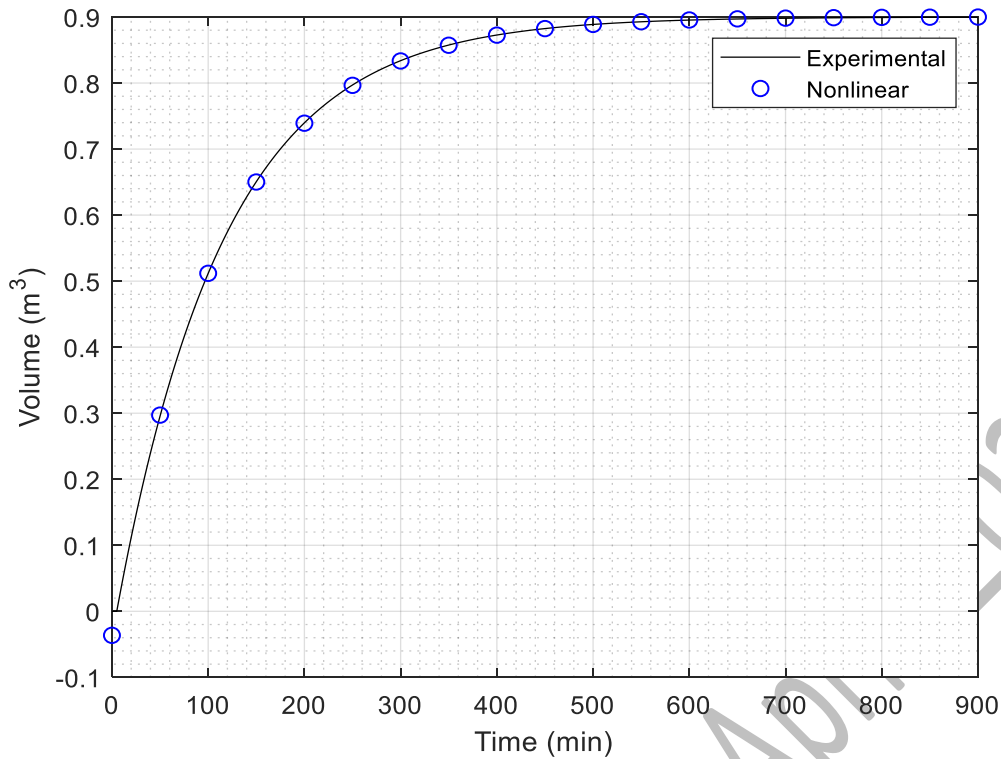


Figure 2: Comparison between experimental and nonlinear model data

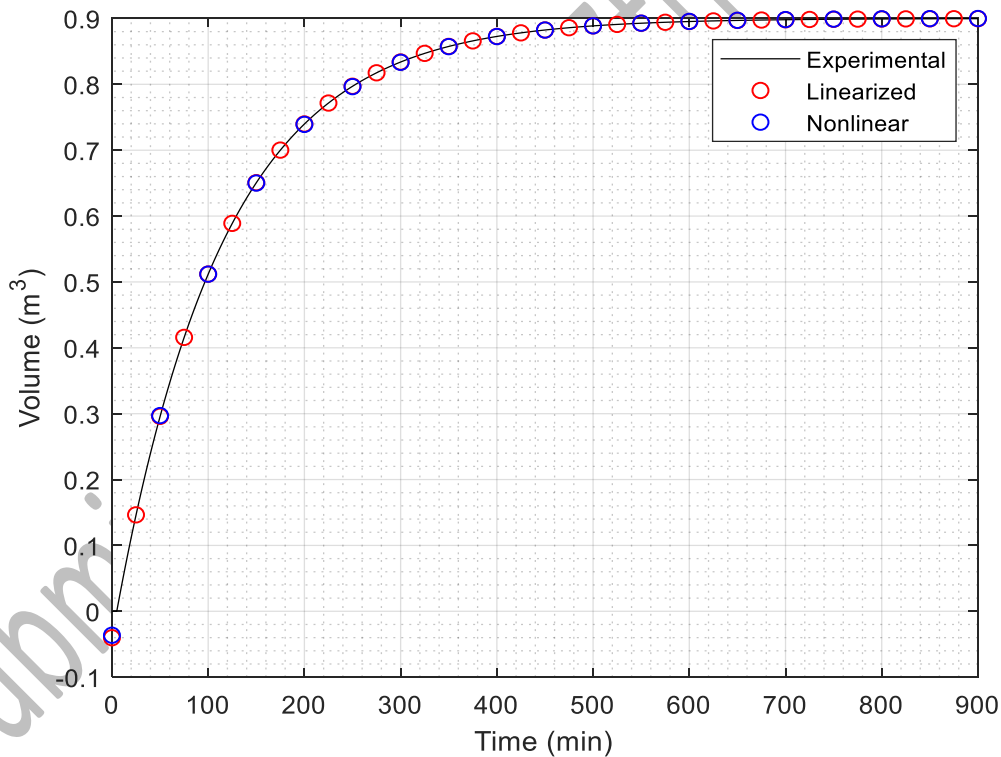


Figure 3: Comparison between experimental, linearized model and nonlinear model data

Table 1: Performance criteria of the regression analyses

Criterion	Linearized regression	Nonlinear regression
SAE	0.167054	0.444734
MAE	0.000185	0.000494
SSE	0.0035	0.003102
MSE	3.88E-06	3.44E-06

Note: Figures 1 – 3 and Table 1 may just be taken as samples for the formats of the results.