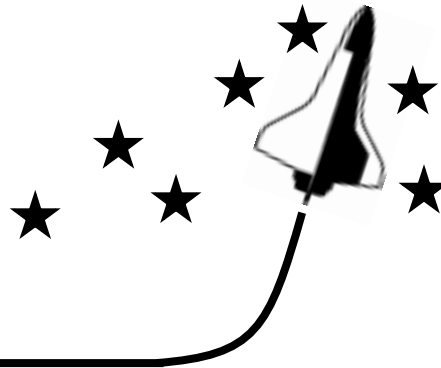


FACULTY NOTES

The LTAs and Spinoffs are designed so that each professor can implement them in a way that is consistent with his/her teaching style and course objectives. This may range from using the materials as out-of-class projects with minimal in-class guidance to doing most of the work in class. The LTAs and Spinoffs are amenable to small group cooperative work and typically benefit from the use of some learning technology. Since the objective of the LTAs and Spinoffs is to support the specific academic goals you have set for your students, the Faculty Notes are not intended to be prescriptive. The purpose of the Faculty Notes is to provide information that assists you to take full advantage of the LTAs and Spinoffs. This includes suggestions for instruction as well as answers for the exercises.



FACULTY NOTES

SPINOFF 12B

Fitting a Sine or Cosine Curve to NASA Energy Use Data

Comments

Each student should have access to a graphing calculator. This Spinoff will provide an opportunity for students to explore the meaning of shifts, expansions, and contractions in attempting to fit the data with a sine or cosine curve.

In the first version of this activity only FY1997 data were used. It was found that including the first 6 months of FY98 provided a better fit of a sine curve to the data. One explanation may be that Hangar S was in heavy use during FY97 which caused electrical usage to be high (Oct to Dec FY97) and both high and erratic (Jan to Apr FY97). Usage dropped to a more seasonal pattern during the subsequent 11 months.

Solutions

- 1) One building of the three (E&O, Hangar S, Hangar AF) must be identified.
- 2) Answers vary depending upon the choice of building and individual satisfaction with parameters as the guess and check method is used. Answers provided here are based on the 18 months (twelve months of FY97 and the first six months of FY98) for each of the three buildings.

Sine Curve to Fit the Data for the E & O (Engineering and Operations) Building

Estimated Electric Use (kWh)

FY97 and First Six Months of FY1998 Data

Mean: 68874

high: 97920

low: 47040

range: $97920 - 47040 = 50880$

range/2: 25440

Fit sine curve: $y = 25440 \sin(0.5x - 4) + 68874$

Sine Curve to Fit the Data for Hangar S

Estimated Electric Use (kWh)

FY97 and First Six Months of FY1998 Data

Mean: 87463

high: 116360

low: 59480

range: $116360 - 59480 = 56880$

range/2: 28440

Fit sine curve: $y = 28440 \sin(0.5x + 8.7) + 87463$

Sine Curve to Fit the Data for Hangar AF

Estimated Electric Use (kWh)

FY97 and First Six Months of FY1998 Data

Mean: 209564

high: 376320

low: 103680

range: $376320 - 103680 = 272640$

range/2: 136320

Fit sine curve: $y = 136320 \sin(0.5x + 4) + 209564$

The graph of the above sine curve for Hangar AF together with the plot of the data led to further exploration. Relative to the scatterplot of the data, the sine curve appeared to have a period that was too small and an amplitude that was too large. For this reason, additional adjustments were made to the constants affecting both characteristics. These adjustments were made incrementally using many iterations of the guess and check method. A sine curve that works well with the data is the following:

$$y = 100000 \sin(0.4x + 5.1) + 209564$$

Varying the parameters in the curves found for Hangar S and the E&O Building may yield equally satisfying results. Each may be explored further.

Finally, some calculators have trigonometric regression capabilities. A TI-89 was used on the Hangar AF data above. In order to enter the data on the TI-89, APPS, Data/Matrix Editor, and new were chosen. The new file must be named before data may be entered. The values 1, 2, ..., 18 were entered in c1 and the data for Hangar AF in c2. After entering the data, sine regression was done by selecting these menu options: F5 (calc), Calculation type: SinReg, variable 1: c1, variable 2: c2. The sine regression yielded the following equation:

$$y = 31041 \sin(1.4x + 0.2) + 210061.$$

This equation may be entered into the [y=] editor and graphed with the results from the guess and check method used above. The results are very interesting! The guess and check method yielded what appears to be a better fitting curve.

The guess and check method presented in the Spinoff reinforces the role each parameter plays in the sine function and the relation of cyclical data to trigonometric functions. It was selected for these reasons.

- 3) A hot summer increases the amplitude of the energy use.
- 4) Answers may vary somewhat depending upon the source
- 5) Discussion. The hotter the summer or colder the winter, the more energy used.