# *SPINOFFS*

Spinoffs are relatively short learning modules inspired by the LTAs. They can be easily implemented to support student learning in courses ranging from prealgebra through calculus. The Spinoffs typically give students an opportunity to use mathematics in a real world context.

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|---|---|
| LTA - SPINOFF 12A | Finding the Rate of Return for Energy Saving Investment |
| LTA - SPINOFF 12B | Fitting a Sine or Cosine Curve to NASA Energy Use Data |
| LTA - SPINOFF 12C | Rocket Spies: Codes and Rockets in the 1950's and 1960's |


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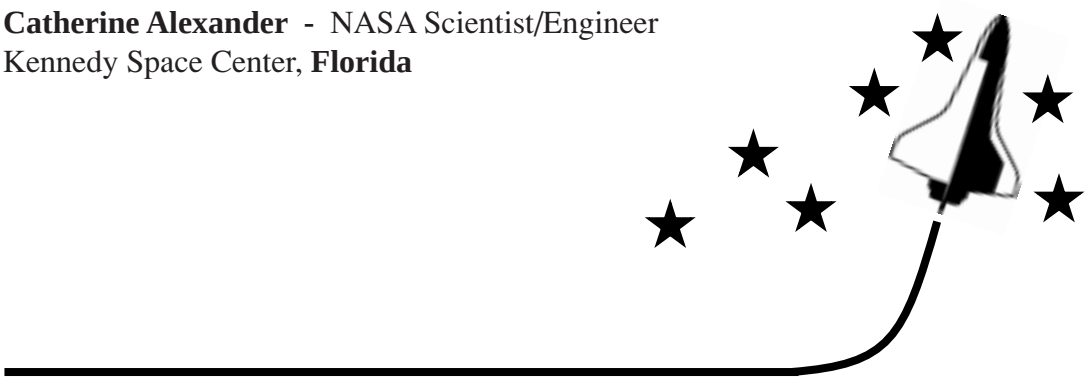


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This project was supported, in part, by the
**National Science Foundation**
Opinions expressed are those of the authors
and not necessarily those of the Foundation

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## SPINOFF 12B

### Fitting a Sine or Cosine Curve to NASA Energy Use Data

Monthly energy related data may fit a sine or cosine curve. The following exercises refer to data found in the tables on the next two pages. These tables provide a record of the monthly electrical energy use for three buildings (Hanger AF, Hanger S, E&O Building) at the Cape Canaveral Air Station in Florida. Before undertaking this Spinoff, you should read pertinent parts of LTA 12, namely "Background Information" and Section 2.

**Exercises**

1) Choose one building. It may be Hangar AF, Hangar S, or the E&O Building.

2) Use a graphing calculator and follow the steps below to fit a sine curve (or cosine curve) to the NASA electric usage data for 18 months (FY97 and the first 6 months of FY98) for the building you selected.
   a) Number the first list in your graphing calculator with 1 to 18.
   b) Select a building and enter its energy use data for all 12 months of FY97 and the first six months of FY98.
   b) Calculate one-variable statistics on the second list.
   c) Record the mean and range for the data.
   d) Set a viewing window with Xmin = 0, Xmax = number of data points (18), Xscl = 2, Ymin = lowest number in second list, Ymax = highest number in second list,
   Yscl = range/10.
   e) Use Statistical Plot to graph the data.
   f) Enter the mean as one equation, Y = mean, in [y=]. Does the mean pass horizontally through the middle of the data?
   g) In [MODE] select [Radian] option.
   Set up a first guess for the equation using these suggestions for starting values.
   $Y = a \cdot \sin( bx + c ) + d$
   Let a = range/2.
   Let b = 0.5.
   We expect there to be a 12 month seasonal cycle or period.
   The period for the general sine function ($y = k \cdot \sin x$) is $2\pi$ or approximately 6.28 radians.
   The value of b, the coefficient of x, determines the period according to the formula: period = $2\pi/b$.
   We want a period close to 12 radians so we let b = 0.5.
   The coefficient b = 0.5233333 is more precise but 0.5 works adequately.
   Let d = mean.
   h) Enter the sine equation into a second equation in [y=].
   i) Use guess and check to set the parameter c (the source of the shift left or right) so as to match any cyclic behavior in the graph of the data.

3) If a summer is particularly hot, which will change: the amplitude or the period of the energy use curve? Discuss which one and why.

4) Find the average monthly temperatures at Cape Canaveral for fiscal years 1996, 1997, and 1998. (Use the internet, an almanac, or other source for your research.)

5) Discuss your answers to Exercises 2 and 3 in light of the temperatures found in Exercise 4.

**Table 1 E & O (Engineering and Operations) Building - Electricity Use in kWh***

| Month | FY96 (kWh) | FY97 (kWh) | FY98 (kWh) |
|---|---|---|---|
| Oct | 79,130 | 70,320 | 87,120 |
| Nov | 67,910 | 61,920 | 60,720 |
| Dec | 58,010 | 56,280 | 60,650 |
| Jan | 51,870 | 80,720 | 56,280 |
| Feb | 50,990 | 52,560 | 47,880 |
| Mar | 55,570 | 69,000 | 47,040 |
| Apr | 64,500 | 58,560 | 59,020 |
| May | 75,600 | 71,760 | 69,210 |
| Jun | 75,600 | 77,520 | 80,400 |
| Jul | 86,140 | 90,240 | 89,870 |
| Aug | 93,550 | 93,240 | 95,290 |
| Sep | 96,010 | 97,920 | 95,330 |

* The data for FY97 and Oct to Mar FY98 are actual data from NASA. Other data are estimated from NASA data. The E&O Building is an administrative office building at Cape Canaveral Air Station.

**Table 2 Hangar S - Electricity Use in kWh #**

| Month | FY96 (kWh) | FY97 (kWh) | FY98 (kWh) |
|---|---|---|---|
| Oct | 92,890 | 116,360 | 97,520 |
| Nov | 81,200 | 100,000 | 82,080 |
| Dec | 69,940 | 80,180 | 71,280 |
| Jan | 61,890 | 84,320 | 67,800 |
| Feb | 59,000 | 77,520 | 61,760 |
| Mar | 61,990 | 101,440 | 59,480 |
| Apr | 70,120 | 94,600 | 64,980 |
| May | 81,410 | 87,840 | 74,780 |
| Jun | 93,080 | 95,240 | 86,600 |
| Jul | 102,290 | 103,440 | 97,530 |
| Aug | 106,780 | 92,240 | 104,910 |
| Sep | 105,440 | 101,240 | 106,920 |

**#** The data for FY97 and Oct to Mar FY98 are actual data from NASA. Other data are estimated from NASA data. Hangar S is the building where the Self-Contained Atmospheric Pressurized Ensemble (SCAPE) suits are maintained, cleaned, and refurbished. The SCAPE Suits protect workers as they load the hydrazine fuel into the Orbiter's maneuvering engines

**Table 3 Hangar AF - Electricity Use in kWh ***

| Month | FY96 (kWh) | FY97 (kWh) | FY98 (kWh) |
|---|---|---|---|
| Oct | 120,230 | 288,000 | 139,520 |
| Nov | 134,270 | 218,880 | 103,680 |
| Dec | 166,850 | 229,120 | 125,440 |
| Jan | 210,000 | 236,800 | 122,880 |
| Feb | 253,150 | 264,960 | 149,760 |
| Mar | 285,730 | 296,960 | 154,880 |
| Apr | 299,780 | 248,320 | 253,150 |
| May | 291,830 | 268,800 | 285,730 |
| Jun | 222,700 | 199,680 | 299,780 |
| Jul | 178,430 | 376,320 | 291,860 |
| Aug | 141,890 | 185,600 | 263,860 |
| Sep | 152,020 | 162,560 | 180,000 |

***** The data for FY97 and Oct to Mar FY98 are actual data from NASA. Other data are estimated from NASA data. When the two white Solid Rocket Boosters are recovered from the Atlantic Ocean after Shuttle launch, they are taken to Hangar AF. They are then refurbished before being refueled for another launch.