Precalculus

Sinusoidal Modeling – Real World Application Project

Now that we have completed our study of sinusoids, we can use our knowledge to apply it to the real world around us. We should now understand that any variable that is cyclical, harmonic, oscillating, or periodic in nature can be modeled graphically by a sine or cosine wave. There are countless applications of sinusoid modeling in real life. Some of these applications include:

-Changes in Temperature over time

-Hours of daylight over time

-Population growth/decay over time

-Ocean wave heights (high and low tides) over time

-Sound waves

-Biorhythm waves

-Electrical currents

-Ferris wheels and roller coasters

-Tsunamis and tidal waves

-Earthquakes

-Wheels, Trampolines, Swings

TASK: Your task is to investigate any real-world phenomenon that can be modeled by a sinusoid. You must research and collect data, develop a predictive model, graph it, and present it to the class using a visual presentation platform like Prezi, Show Me, iMovie, Powerpoint, etc. You will be given the freedom to choose any topic, and the freedom to be as creative and outside-the-box with this project as you wish.

This project will be done in **groups of 2 or 3.**

This project will be worth **24 points (a quiz grade).**

This project will be due on _____.

Task Details:

- Collect no less than 12 real-world data points that can be modeled sinusoidally. The more data, the better! Providing 24 or more data points will earn you maximum points on the rubric.

- A predictive model of the format $y = A\sin(Bx + C) + D$ or $y = A\cos(Bx + C) + D$ for the data must be developed using the techniques we learned in class. This model could be used to predict outcomes into the future.

- A neatly organized graph of the original data, and a graph of your developed model must both be embedded in your presentation. To produce these graphs you may use your graphing calculators, the Desmos app, or you may draw the graphs yourselves. Pictures or screenshots of your graphs may be used. The objective is to compare the two graphs side-by-side or on top of one another, so you could see how accurate and predictive your model is.

- A reflection must be submitted with your project (1-2 paragraphs). This reflection should be neatly and logically written/typed with no grammatical errors, and should summarize your experience in doing this project. What did you learn? What did you enjoy or dislike? What would you change? How well did you work with your partner? Etc.

Sinusoidal Modeling Rubric

Criteria	Model/Exemplar (4 points)	Proficient (3 points)	Developing (2 points)	Beginning (1 point)	Score
Data Collection	Data is authentic, appropriately labeled and clearly presented in an X-Y table. Contains 24 or more measurements.	Data is authentic, appropriately labeled and clearly presented in an X-Y table. Contains 13-23 measurements.	Data is authentic, appropriately labeled and clearly presented in an X-Y table. Contains 12 measurements.	Data is incorrectly labeled, not presented in an X-Y table, and contains less than 12 measurements.	
Mathematical Calculations/Model Development	All calculations are very clear, organized, and neatly completed with no inaccuracies.	All calculations are clear, organized, and neatly completed with 1-2 inaccuracies.	Most calculations are clear, organized, and neatly completed with 3-4 inaccuracies.	Calculations are unclear and disorganized and 5 or more inaccuracies may be present.	
Graphs	All graphs are neatly produced, axes are appropriately scaled and labeled, data points are accurately plotted, colorful, and smooth curves are drawn.	All graphs are neatly produced, axes are appropriately scaled and labeled, data points are accurately plotted, colorful, and smooth curves are drawn.	All graphs are not neatly produced, axes are not appropriately scaled and labeled, data points are not accurately plotted, and smooth curves are not drawn.	All graphs are not neatly produced, axes are not appropriately scaled and labeled, data points are not accurately plotted, and smooth curves are not drawn.	
Visual Presentation	The presentation is clear, colorful, creative and entertaining, shows a great deal of editing and audio/visual effects, keeps the audience fully engaged, fully utilizes available technology, and lasts 5-10 minutes.	The presentation is clear and colorful, shows some editing and audio/visual effects, keeps the audience mostly engaged, and fully utilizes technology, and lasts 3-5 minutes	The presentation is bland and basic, does not show editing or effects, keeps the audience moderately engaged, and does not fully utilize technology, and lasts 1-2 minutes	The presentation is erratic and poorly produced, lacks effort, does not show any editing or effects, the audience is not engaged, and does not utilize technology, and lasts under 1 minute.	
Effort and Collaboration	An exceeding amount of time and effort are present and the task responsibilities were shared equitably among group partners.	A substantial amount of effort is present and the task responsibilities were shared equitably among group partners.	An average amount of effort is present, and the task responsibilities were not shared equitably among group partners.	A poor amount of effort is present, and the task responsibilities were not shared equitably among group partners.	
Reflection	Writing is clear, concise, and well organized. Thoughts are expressed in a coherent and logical manner. Contains 2 or more paragraphs with very few grammatical errors present.	Writing is mostly clear, concise, and well organized. Thoughts are expressed in a coherent and logical manner. Contains 1-2 paragraphs with several grammatical errors present.	Writing is unclear and disorganized. Thoughts are not expressed in a logical manner. Contains 1-2 paragraphs with several grammatical errors present.	Writing is unclear and disorganized. Thoughts ramble and make little sense. Contains 1 paragraph with many grammatical errors present.	

Example Project Ideas:

https://www.youtube.com/watch?v=UTuP452WrLU

https://www.youtube.com/watch?v=y3CI02oBXAY

https://www.youtube.com/watch?v=blEbS_YBUXg

- A city averages 14 hours of daylight in June, 10 in December, and 12 in both March and September. Assume that the number of hours of daylight varies sinusoidally over a period of one year. Develop a model for **d(t)**, the number of hours of daylight, as a cosine function of **t**.

- The tides at the beach are cyclical. At midnight, low tide is 4 feet, while at noon, high tide is 10 feet. Develop a model for these tides.

- An electrical current alternates between 60 V and 120 V and back every 0.2 seconds. Assume the initial voltage was 120 V. Develop a model for these currents.

- A Ferris wheel is 50 feet in diameter, with the center 60 feet above the ground. You enter from a platform at the 3 o'clock position. It takes 80 seconds for the Ferris wheel to make one revolution clockwise. Find the model that gives your height above the ground at time t (t=0 when you entered).

- As the assistant meteorologist, you have been asked to research tsunamis, also known as tidal waves. They are ocean waves produce by earthquakes and can move through the water undetected for hundreds of miles at great speed. These waves can be represented by a sine graphs with a very long wavelength, or period, and very small amplitude. Tsunami waves only attain monstrous size as they approach the shore. Use your research to graph a tsunami wave, find its sinusoidal equation, and analyze its amplitude and wavelength.

- You have been hired to design a roller coaster for the next World Expo. For the committee, you need to explain the coaster route in terms of a combination of trigonometric functions on a continuous graph. Research famous coasters like the Manta, Wicked, Batman the ride, and others to find heights, lengths and routes of thrilling coasters. Present your equations and explanations to the class.

- The pressure P (in millimeters of mercury) against the walls of the blood vessels of a person is modeled by $P = 100 - 20 \cos (8\pi/3)t$, where t is the time in seconds. Graph the model. Explain how to find the period of the function. The period is one cycle, and one cycle is equivalent to one heartbeat. Then find the person's pulse rate in heartbeats per minute.

- Radio waves transmit sound in two ways. For an AM station, the amplitude of the wave is modified to carry sound. Hence, AM stands for "amplitude modification". For an FM station, the frequency is modified to carry sound. Thus, FM stands for "frequency modification". Sketch both AM and FM waves, and develop a model.

- Circadian rhythm is the daily biological pattern by which body temperature, blood pressure, and other physiological variables change. Data shows typical changes in human body temperature over a 24-hour period ($t = 0$ corresponds to midnight). Find a cosine curve that models the data.

- The rabbit population in a field fluctuates with the seasons. In January, the cold weather and lack of food reduces the population to 500. In July, the population rises to its high of 800. This cycle repeats itself. Develop a model.