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| **Project Title** | Suspension bridge | | |
| **Project Code** | **1** | **Course Name** | Differential Equations |
| **Professor** | **Et**har Ahmed Abdelsalam | | |
| **TA** | **Fatma Helal Mabrouk** | **Mentor Name** | **Adham Haggag/Ahmed Nabil** |
| **Team Name** | **1% of the 1%** | | |
| **Team Members** | **Youssef Hassan** | **Eslam Nasr** | **Abdallah Khaled** |
| **Yassin Saad** | **Michael Wagdy** | **Philopater Ayman** |
| **Problem Summary** | Suspension bridges are a type of bridge that are supported by cables suspended from tall towers. These bridges are known for their elegant design and long span, but they also present unique engineering challenges due to their reliance on cables to support the weight of the bridge and its deck. One such challenge was demonstrated by the collapse of the Tacoma Narrows Bridge in 1940, which was caused by a phenomenon known as "aeroelastic flutter." This is a type of vibration that occurs when the bridge deck starts to oscillate in the wind. The oscillations became stronger and stronger, eventually causing the bridge to collapse. | | |
| **Methodology** | []  ]  This equation is a second-order nonlinear differential equation. It involves the second derivative of a function y(t) with respect to time t, denoted by y''(t). The second derivative represents the rate of change of the first derivative of y(t), which is itself a measure of the rate of change of y(t).   * d is a positive constant representing the damping coefficient, which determines the degree to which the system is damped or slowed down by friction or other dissipative forces. * K is a positive constant representing the spring constant, which determines the stiffness of the spring and the amount of force required to stretch or compress it. * m is a positive constant representing the mass of the object attached to the spring. * a is a positive constant representing the acceleration due to gravity. * l is a positive constant representing the length of the spring when it is not stretched or compressed. * θ is a variable representing the angle between the spring and the vertical direction.   The right-hand side of the equation represents the force acting on the mass due to the spring. The first term inside the brackets, e^(y-l sinθ)-1, represents the force due to the stretch of the spring, while the second term, e^(y+l sinθ)-1, represents the force due to the compression of the spring. These terms are derived from the equations of motion for a spring-mass system. | | |
| **Achievements and Skills Gained** | 1. The collapse of the Tacoma Narrows Bridge was a significant event that led to changes in the way suspension bridges were designed and engineered. 2. Engineers gained valuable skills and knowledge in the use of differential equations and other analytical tools to predict the behavior of suspension bridges under various loads and forces. 3. This knowledge has been applied in the design and construction of many safe and stable suspension bridges around the world. | | |

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| **Project Title** | Suspension bridges |
| **Main Results** | Diagram  Description automatically generatedGraphical user interface, chart  Description automatically generated with medium confidenceHere is a short clip during within the first 10 seconds of start       Here is a short clip after about 30 seconds |
| **Discussion and Conclusion** | The collapse of the Tacoma Narrows Bridge was a tragic event that highlighted the importance of thorough structural analysis and the need to consider all potential load conditions when designing a structure. Through the use of differential equations and mathematical modeling, engineers were able to understand the dynamics of the bridge and identify the cause of its collapse. Today, these techniques are widely used in the design and analysis of structures to ensure their safety and reliability. |
| **References** | "Tacoma Narrows Bridge." Encyclopedia Britannica. <https://www.britannica.com/topic/Tacoma-Narrows-Bridge>  "The Tacoma Narrows Bridge Collapse." The Physics Classroom. <http://www.physicsclassroom.com/class/waves/Lesson-3/The-Tacoma-Narrows-Bridge-Collapse>  The Editors of Encyclopedia Britannica, “Suspension bridge | engineering,” Encyclopedia Britannica. 2019.  <https://www.britannica.com/technology/suspension-bridge> |
| **Future Work and Suggestions** | Future Work:   * The current model can be extended to include more realistic factors such as wind forces, variations in temperature, and human movement on the bridge. * The model can be used to optimize the design of new bridges by simulating unique design configurations and comparing their dynamic responses. * The model can be used to predict the long-term behavior of existing bridges, such as determining their useful lifespan and identifying potential failure points.   Suggestions:   * It may be useful to incorporate machine learning techniques to improve the accuracy of the model, such as using neural networks to approximate the differential equations. * The model could be further validated by comparing the simulated responses to data collected from real bridges. * Further research could be done to investigate the influence of different factors on the dynamic response of bridges, such as the material properties and geometry of the structure. |