In-Class Activity 7 - Linear Pendulum
ME 3001-002- Mechanical Engineering Analysis - Spring 2024

Learning Objectives:

- Demonstrate solving an ordinary differential equation with an analytical method
- Demonstrate approximating the solution to an ordinary differential equation with a numerical method
- Practice using plotting in MATLAB to to display solution results

Peer Collaboration:

This is an individual assignment, but you are encouraged to discuss the problem with your peers. You must write your own program and submit as an individual, but you can share ideas about the algorithm with your peers and the instructor.

Overview:

The non-linear pendulum model exposed to a cose is given above.

$$\frac{d^2\theta}{dt^2} + \frac{g}{l}\sin\theta = f_{wind}$$

$$l = 0.35 \ (m), f_{wind} = 5\cos\theta \ (N)$$

The model can be linearized with the small angle indentity with results in the following equation.

$$\frac{d^2\theta}{dt^2} + \frac{g}{l}\theta = f_{wind}$$

The displacement of the pendulum can be found as the solution to the ODE as an initial value problem. Initial conditions are given.

$$\theta(0) = 25°, \quad \frac{d\theta}{dt}|_{t=0} = 0$$

Activity:

1. Find the displacement of the pendulum by solving for the linearized pendulum ODE given the initial conditions using an analytical method. Clearly show all of the steps required find solution.

2. Write a MATLAB program use Euler's Method or alternate numerical method to approximate the solution condidering the same initial conditions. The program should plot the analyical and numerical results in the same figure for comparison. Do the results agree? If not suggest sources of error.

3. Write a brief description of how your program works to solve the problem. This can be a few sentences or a bulleted list.

Submission:

- Submit the MATLAB program as a .m file. The program should run free from errors and produce the results described in the assignment including any figure.

- Include answers to any discussion questions in a seperate document or the assignment submission textbox.