Design Project #3

Force Analysis of a Linkage System

Due: Friday March 26, 2021 uploaded to Blackboard by 11:59pm

Introduction: In last week's project you computed the kinematic analysis of a planar mechanism which involved the position analysis, followed by the velocity analysis and then the acceleration analysis. Now you will compute the subsequent forces for the system based on given specifications. For this project you will use concepts you have learned in classes (specifically linkage kinematics and force dynamics).

Project Description: As a reminder, Figure 1 shows a schematic of the mechanism of a folding umbrella. The slider can move upward with respect to the sliding shaft to move other links of the umbrella upward and outward during use.

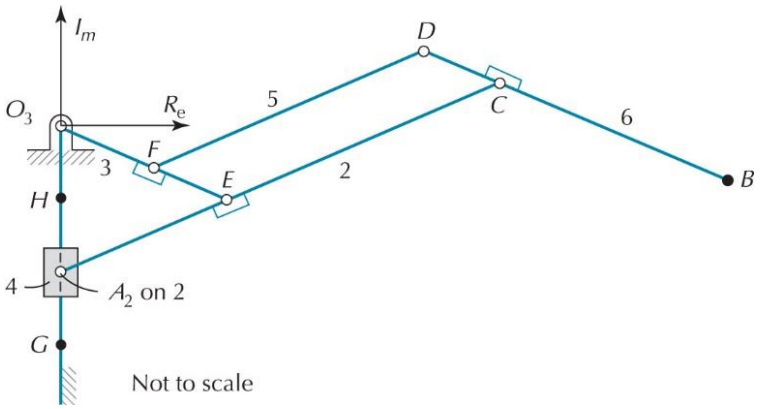

Figure 1: Mechanism used in a folding umbrella.

Using the dimensions and joint position functions from Design Project 2, calculate the forces at each of the joints for various opening times (τ) if a weight of 2.0 kg is hung from point B and the bars in the mechanism all have a mass of 0.1 kg/cm. Opening times will vary from slow to fast ($\tau = 0.02\ s,\ \tau = 0.2\ s, \tau = 2\ s, \tau = 20\ s,\ \tau = 200\ s$).

Design Project 3 Report Requirements

Generate a maximum 5 - 8 page write up that contains at least the following:

1. A short introduction to the project (a paragraph is sufficient).
2. An analytical procedure that describes what you did for the solution to the problem.
3. Plots containing:
    a. Force at each joint over time for $\tau = 0.02\ s$
    b. Force at each joint over time for $\tau = 0.2\ s$
    c. Force at each joint over time for $\tau = 2.0\ s$
    d. Force at each joint over time for $\tau = 20\ s$
    e. Force at each joint over time for $\tau = 200\ s$

    Make sure the plots are properly labeled (x-axis label, y-axis label, title, and grid). Note: you need to have the correct trajectory, velocity and acceleration of each joint before you complete your force analysis.
4. A comparison and discussion of your plots: what the various plots show, any observations you have about how changing the time in which the slide occurs affects the force analysis performed on the mechanism.

Project Grading Rubric Guideline

INTRODUCTION (15%)

- Describe the problem that is being studied
- Explain the importance and relevance of the problem
- Must have properly listed citations

ANALYTICAL PROCEDURE (20%)

- Explain steps taken and pertinent equations used to solve the problem (with description of what variables mean)
    - Definition of the problem (include a figure)
    - State the givens
    - Make the appropriate assumptions
    - Explain mathematical models that will be used in the solution
    - Develop a procedure for analysis of the problem
    - Brief explanation of anticipated results

RESULTS (20%)

- Copies of all asked for plots

INTERPRETATION (25%)

- Descriptions of the significant results in the plots
- Engineering observations about utilization of plots

CODE LISTING (10%)

FORMATTING AND CORRECT CITATIONS (10%)

Common mistakes that cost points:

- Project is turned in late
- Incorrect Calculations
- Figures not labeled (with legends if necessary)
- No references
- Incorrect, poorly formatted, or misleading tables and charts
- Grammar mistakes
- Irrelevant results
- Repetition