MAE 162A: Introduction to Mechanisms and Mechanical Systems

Final Project:

Design of a horizontal-platform mechanism

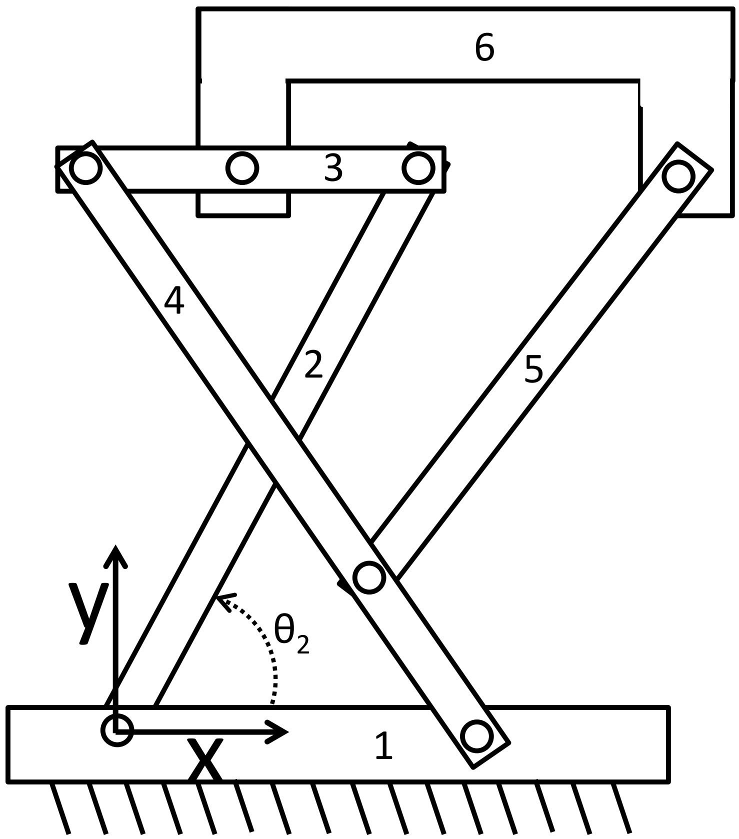

Figure 1. Horizontal-platform mechanism

Project Description

Design and simulate a mechanism, shown in Fig. 1, using Matlab and SolidWorks. The purpose of this mechanism is to provide horizontal motion for the tabletop (link 6), within a specified tolerance. The tabletop must be able to travel at least 850mm along the x-axis, during which the vertical translation of the table's center of mass must be less than 4mm. The angular deviation of the tabletop must be less than 1° from the horizontal, throughout the entire motion of the mechanism. The input link (i.e., link 2) is driven by a motor located at the pin joint on which the origin is shown in Fig. 1.

The entire mechanism must be able to fit within a space that is 850mm wide (x-direction) by 1050mm tall (y-direction) for at least one position. In other words, for at least one value of θ_2, the mechanism can fit within the footprint specified. None of the links may rise above the top surface of the tabletop during the entire motion of the mechanism. Assume that all of these links lie on the same plane and that they can each pass through each other (i.e., the mechanism is a planar mechanism like the other mechanisms that we have studied this quarter). Assume that each link within the mechanism is made of aluminum and possesses a constant density of 2,698.9kg/m^3. The out-of-plane thickness of each link including the tabletop is 30mm. The mechanism is intended to be operated on Earth where gravity is acting downward in the negative y-direction. Assume all the joints are frictionless.

<u>Specific Deliverables</u>: (Read these carefully and provide ALL the information requested)

(1) Determine the dimensions of each link (i.e., their lengths, widths, and thicknesses) that allow the mechanism to achieve its intended functional requirements. Note that all the links are rectangular prisms except the tabletop. For all rectangular prism links, assume their widths are the same as their thicknesses (i.e., 30mm). Once you have determined these dimensions as well as the locations where they attach to each other via R-joints as shown in Fig. 1, use SolidWorks to CAD your final design. Submit a planar screen shot of this model and clearly label its dimensions. Label the location of the tabletop's center of mass as well. This screen shot should show the mechanism in a position such that it fits within the specified footprint. Draw a rectangle around your picture showing this footprint (i.e., 850mm x 1050mm) shown drawn to scale.

(2) For your specific design, determine the maximum and minimum θ_2 (i.e., θ_{2max} and θ_{2min}) between which the motor must rotate link 2 back and forth with respect to link 1 such that the table achieves its desired oscillating stroke (i.e., >850mm along the x-axis).

(3) Create a graph using MATLAB to display the horizontal displacement of the tabletop's center of mass along the x-axis as a function of θ_2 to show that it can span this desired stroke between θ_{2min} and θ_{2max}.

(4) Create a graph using MATLAB to display the vertical displacement of the tabletop's center of mass along the y-axis as a function of θ_2 to show that the center of mass does not dip or rise more than 4mm in the vertical direction between θ_{2min} and θ_{2max}.

(5) Create a graph using MATLAB to display the angular rotation of the tabletop in the z-direction as a function of θ_2 to show that the tabletop does not rotate more than 1^o over its full stroke between θ_{2min} and θ_{2max}.

(6) If the motor drives link 2 with a sinusoidal displacement of

$$\theta_2 = \frac{(\theta_{2\max} - \theta_{2\min})}{2}\sin(\omega t) + \frac{(\theta_{2\max} + \theta_{2\min})}{2},$$

where ω is 1^o/sec and t is time, use MATLAB to display the input torque of the motor as a function of time over three full cycles of its oscillating stroke. I would recommend converting all dimensions from degrees to radians!

Other Details:

In addition to the specific deliverables specified previously, please include hand calculations, MATLAB scripts, and anything else that will help us know what approach you took to solve the problem so that we can give you partial credit. Please write a brief but professional report summarizing your work and combine everything into one pdf document. Label the document accordingly:

Firstname_Lastname.pdf (e.g., Jonathan_Hopkins.pdf)

Also please check the syllabus for the day, time, and email to which the project needs to be sent. **No mercy will be extended to projects that are late for any reason!!!** You can always submit your project as early as you like.

Good luck!