ME345 Modeling and Simulation, Fall 2018
Case Study 1
Assigned: Friday October 5, 2018
Due: Monday October 29, 2018, 11:59pm, submitted via CANVAS (one per group)

Note 1: There are two separate problems for Case Study 1. Note that the problems are NOT equally weighted.

Note 2: Each of the Case Studies can be done in groups of up to 3 students. Each student is expected to contribute equally to the group work. No two students can be in the same group for more than one Case Study (as discussed in class). Students will be asked to complete an anonymous Group Member evaluation after submitting the Case Study assignment.

Note 3: You are STRONGLY encouraged to complete the assignment prior to this due date!

Problem 1: Geneva Mechanism (40%):

The Geneva mechanism shown below is a mechanism for producing intermittent rotation. Pin P in the integral unit of wheel A and locking plate B engages the radial slots in wheel C thus turning wheel C one fourth of a revolution for each revolution of the pin. At the engagement position shown, $\theta = 45^{\circ}$.

1) For a constant clockwise angular velocity $\omega 1 = 2$ rad/s of wheel A, determine the corresponding counterclockwise angular velocity $\omega 2$ of wheel C for $\theta = 20^{\circ}$ (analytically)

2) Using appropriate CAE software, model this mechanism, and plot the angular velocity and the angular acceleration of a point at the end of the 'maltese cross' versus time. How do the maximum angular velocity and accelerations change for different constant values of $\omega 1$?

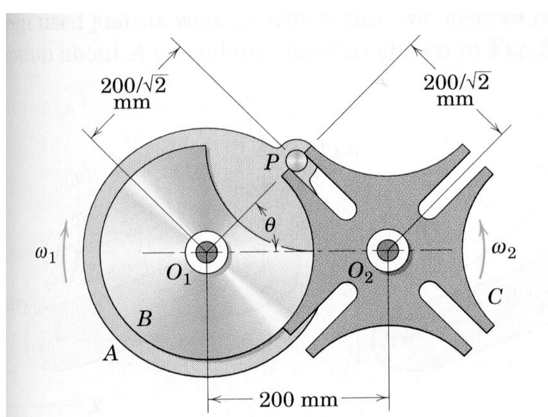


Figure 1. Geneva Mechanism

You are free to select any dimensions you wish to run the mechanism. Also note that a "Google" search will provide several websites that discuss Geneva mechanisms in detail. *Hint: you may wish to consider the use of a 'tangent mate' for your analysis.*

Report:

You will need to submit an engineering report of your analysis to the company president (i.e. the professor). The report should be **well-organized, clear, and concise**, and *at minimum* address the points listed below. The report should also provide a justification of why the results that you have obtained are sensible. **NOTE: just submitting the software output without your analysis and discussion is NOT acceptable.**

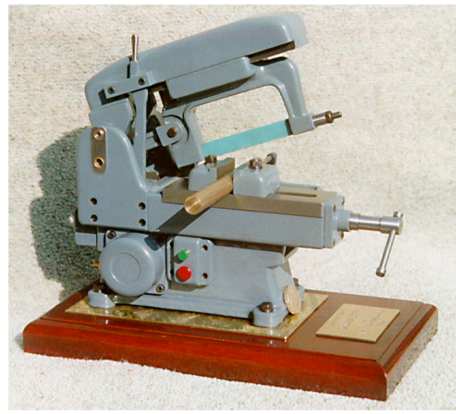
- Describe briefly the specifics of the creation of your model and the setup of your analysis. In particular mention any aspects that you feel might be 'noteworthy' or unusual.
- Compare the behavior of the mechanism to a simplified analytical model and/or a model of the linkage system using another package.[1] Comment on the similarities and differences between the analytical model and the simulation results.
- Discuss *in detail* how the results from the model are sensible and reinforce your understanding of the behavior of the system.
- Comment on any recommendations to your supervisor regarding 'next steps' in analyzing and/or improving your mechanism?

While it is natural to discuss your work and progress with your colleagues (i.e. classmates), **individual group analyzes and reports are required (this cannot be emphasized enough – work that fails to meet this requirement will not be given credit for the assignment)**. Your supervisor (i.e. the TA) is also available to answer thoughtful questions as you work on the project, but it would be unprofessional to overly rely on your supervisor to complete your assignment.

[1] If you are not currently in ME358 and have not taken the class in the past, please be sure to work with a classmate in your group who is familiar with these programs when doing this analysis. Note that the use of even simpler analyzes (not requiring software from ME 358) would also be appropriate here.

<u>Problem 2: Powersaw (60%):</u>

Figure 2 shows a power hacksaw used to cut metal. Link 5 pivots at O_5 and its weight forces the saw blade against the workpiece while the linkage moves the blade (link 4) back and forth on link 5 to cut the part. It is an offset slider-crank mechanism.



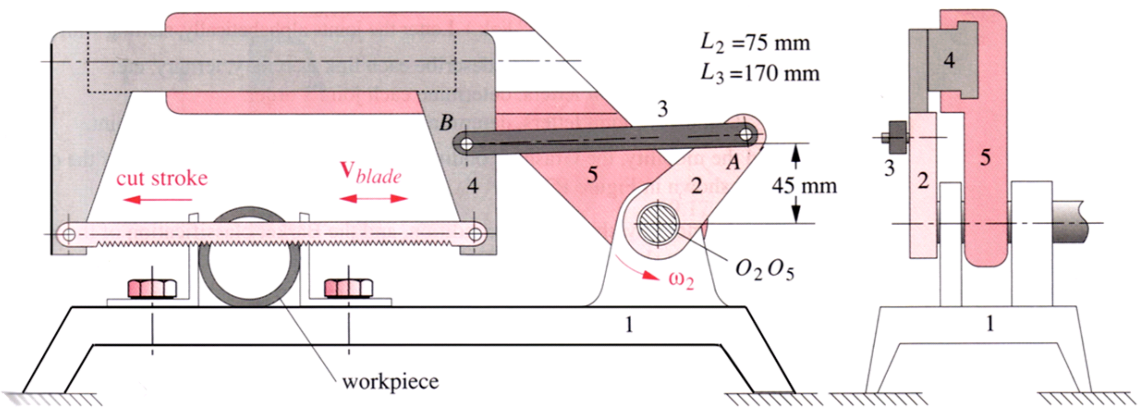


Figure 2. Picture and schematic of a power hacksaw.

Using Solidworks and related software, build, assemble, and simulate the system. Define those dimensions not specified as you wish. Part geometry and materials are not confined, but use your engineering skills and common sense to build the most realistic parts. Any helpful source (web, textbooks, etc.) are allowed and recommended. (All sources must be referenced in your report.)

Report:

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- Describe briefly the specifics of the creation of your model and the setup of your analysis. In particular mention any aspects that you feel might be 'noteworthy' or unusual.

- Summarize the motion of the powersaw by looking at the behavior of the system as a function of the angle of the crank (link 2). In particular, provide plots of the horizontal displacement, velocity, and acceleration of the blade (link 4) as a function of one complete revolution of the crank.

- Compare the behavior of the mechanism to a simplified analytical model and/or a model of the linkage system using another package (this could be the programs *Working Model* or *Four Bar* program as covered in ME358: Machine Dynamics and Mechanisms, for example).[2] Comment on the similarities and differences between the analytical model and the simulation results.

- Discuss *in detail* how the results from the model are sensible and reinforce your understanding of the behavior of the system.

- Using your properly working model, now extend your analysis to discuss the 'working envelope' of the power hacksaw. Examples of topics which could be addressed here include [this question is purposefully open-ended to allow you to address different areas of powersaw performance]:

    - What input angular crank velocities (link 2) are necessary to cut different materials? (You may wish to research the optimum cutting speeds for different materials)
    - What is the relationship between crank angular velocity and horizontal cutting motion?
    - How would you design the weight of the guide (link 5) to optimize cutting performance? How does the motion of the blade (link 4) vary as a result of the position of the guide?
    - How does the position of the center of the crank (labeled O_2O_5 on the schematic) affect powersaw performance?

- Are their any recommendations to your supervisor regarding ‘next steps’ in analyzing and/or improving your powersaw mechanism?

While it is natural to discuss your work and progress with your colleagues (i.e. classmates), **individual group analyzes and reports are required [this cannot be emphasized enough – work that fails to meet this requirement will not be given credit for the assignment]**. Your supervisor (i.e. the TA) is also available to answer thoughtful questions as you work on the project, but it would be unprofessional to overly rely on your supervisor to complete your assignment.

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