MIE301 – Lab 3 – 2023
Mechanism Optimization

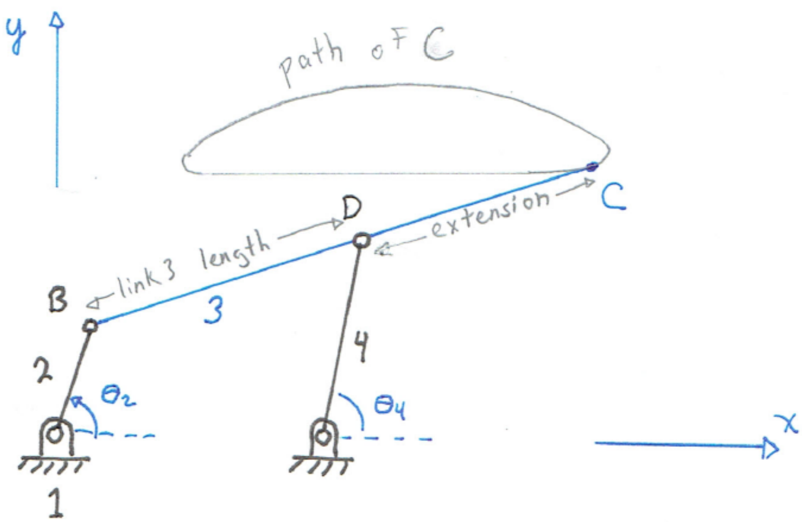
Due: PRA0101: Sep 27, 4 pm, PRA0102: Nov 3 ,4 pm, PRA0103: Sep 31, 4 pm, PRA0104: Oct 24, 4 pm. One week after your assigned lab session on Quercus at 4 pm.

Penalty will be given for late submissions.
TA: Boran Kumral (boran.kumral@mail.utoronto.ca)

- Please include MIE301 Lab3 in the email subject

In this lab you will use Matlab to *optimize* a mechanism design. On paper, once you choose a type of mechanism it is often difficult to choose the *best* link lengths, pivot point positions and geometry to get the best output from your mechanism. You will optimize a straight-line mechanism called Hoeken's Mechanism. This mechanism converts a constant rotation input to an output trajectory of point C with a long region of *approximately* straight motion.

Using vector loop analysis (you will learn it later in October, see book ch. 4) you will be able to write equations for the position of any point on a mechanism as a function of inputs. For this lab, we have calculated the position of point *C* for you in the starter code. The goal of this assignment is to choose the best link 3 length to achieve the longest straight line possible (within some tolerance).

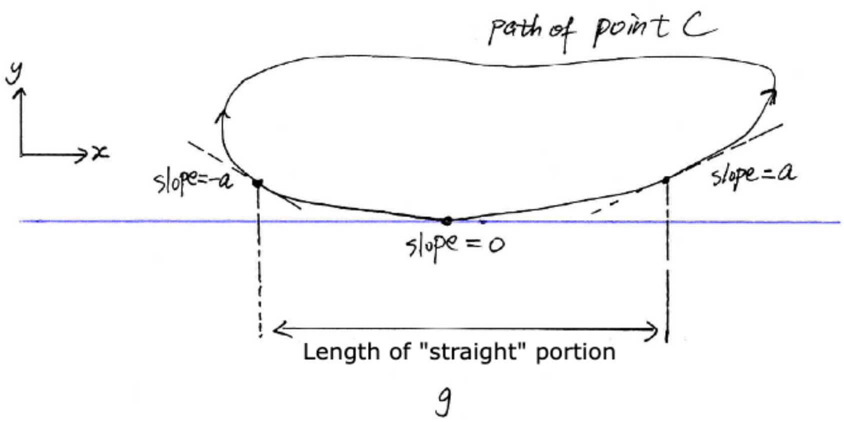


Report: Include your answers and simulations results.

Submission: Upload the following 2 files to Quercus directly:

Lab3report.pdf   lab3problem.m

- Complete the Lab3report.pdf following the report template.
- lab3problem.m should generate the figures for part a), b) and e) in addition to the calculation steps for part c) and d). It is **required** to break the code into sections and each section should produce the figures or perform the calculation for one question, following the order a) to e).



Report Deliverables: Three plots and answers to the questions below.

a) Plot your optimization plot, g as a function of link 3 length. For the optimal design (the one with longest g), report both link 3 length and the straight portion length g.
b) For the optimal design, plot the optimized trace for point C, with the straight portion region precisely marked. Include the optimized mechanism links.
Steps to follow for a) and b):

1. Set link 3 length and plot the path of point C.
2. Define and calculate your straight portion length *g*, given the slope tolerance *a=0.1*. See image above.
3. Repeat step 2 with different values of link 3 length.
4. Plot *g* as a function of link3 length. Identify the optimal values.
Plot the resulting path of point C, with the longest straight portion.

c) For the optimal design, what is the input link angle (θ_2) at the beginning and end of the straight portion?
d) For the optimal design, what are the maximum and minimum speed and acceleration of the trace point C through the straight portion? ($\dot{\theta}_2$= 60 rpm)
e) For the optimal mechanism structure you find, plot the straight portion length g as a function of a for 0.05<a<0.15

- Except for link 3, all other link lengths should be kept as they are in the starter code.
- Hint: remove the pause command to speed up your optimization code.
- Put legends on figures and use distinguishable colors.

Feeling confident? (optional advanced problem): You can also optimize the other link lengths to improve the straightness. Generalize your optimization algorithm to also vary r4 and find the optimal value.

Marking Rubric:

	2 pt	Report is clearly organized
	2 pt	Figures are properly formatted, with labels and units
	4 pt	Plots are correct and show what we asked for
	5 pt	Answer to questions