Kinematics & Dynamics of Machinery (ME 3320)

Recitation - 3

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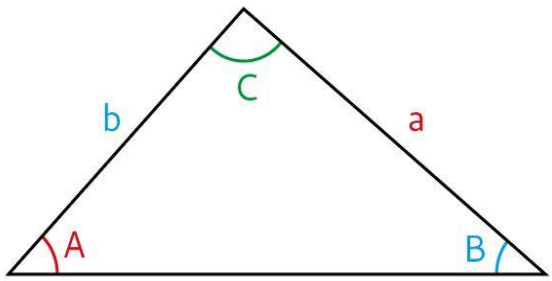
1. **Agenda:**
   - Revision(4-bar Linkage)
   - Problems(Position Analysis, Matlab Simulation of Parameters)

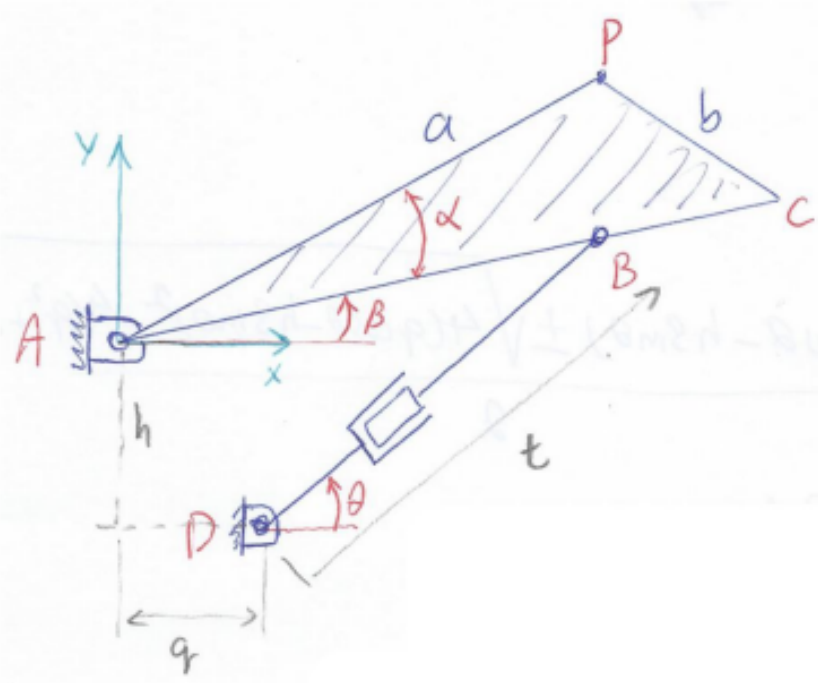
2. **Revision:**
   - **The equation to determine the number of independent loops is:**
   - **What is the link length condition for the shortest link of 4-bar linkage to fully rotate?**
   - **What is the condition to form a foldable linkage?**
   - **What does it mean if we get the boundary value of the input angle as a complex value?**
     - **What can be done in such a situation?**
   - **For a given triangle below, write the law of sines and cosines.**



- **Match the following:**
  (Related to the Door Mechanism Problem)

Distance Constraint	Velocity
Loop Equation	θ
Law of Cosines	t(θ)
Derivative of Position	Acceleration
Second Derivation of Position	$\beta(\theta)$

3. **Problems:**
    - **The linkage shown below is a kinematic sketch of a closing door mechanism with given dimensions. The acceptable value of the prismatic joint is 5 < t < 15.**



q = 3; h = 4; a = 10; d =|AB| = 8; $\alpha = 30^0$

M = 1; A =<0,0>; B = <q+t*cos(θ),-h+t*sin(θ)> = <d*cos(β), d*sin(β)>; D = <q,-h>; d = |AB|

$t(\theta) = \{-2(q*\cos(\theta) - h*\sin(\theta)) \pm \sqrt{4*(q*\cos(\theta) - h*\sin(\theta))^2 - 4(q^2 + h^2 - d^2)}\} / 2$

$\beta(\theta) = \tan^{-1}((-h + t*\sin(\theta)) / (q + t*\cos(\theta)))$

1)Using triangle ABD and cosine law, compute the limits of angle θ for the limits of the prismatic joint t

2) Find the position vector of point P and plot it versus the min and max of θ.

3) Matlab:

3.1 Use Matlab to plot $t(\theta)$ versus $0 < \theta < 2\pi$. Highlight part of the plot that is corresponding to $\theta_{min} < \theta < \theta_{max}$. Do the same for $\beta(\theta)$.

3.2 Plot the position vector P for the allowable values of theta.

(A correct solution is sometimes unusable. It is more often the case for a code script. An ill-formatted code is provided to you that has a single logical bug. Your task is to work in the group and try to understand what the code is doing and find one bug that is in the code. Please refer to the Miscellaneous section for one of the ideas to make a code neat.
(Three tasks: Comment code, Add functions, and Find the bug)

Bibliography:

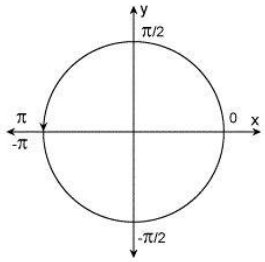
- **Dr. Deemyad's Notes**

Miscellaneous:

- Meaning of atan2(From Matlab Documentation):

Four-Quadrant Inverse Tangent

The four-quadrant inverse tangent, `atan2(Y,X)`, returns values in the closed interval `[-pi,pi]` based on the values of `Y` and `X`, as shown in the graphic.



In contrast, `atan(Y/X)` returns results that are limited to the interval `[-pi/2,pi/2]`, shown on the right side of the diagram.

IEEE Compliance

For real inputs, `atan2` has a few behaviors that differ from those recommended in the IEEE®-754 Standard.

	MATLAB®	IEEE
`atan2(0,-0)`	`0`	`pi`
`atan2(-0,-0)`	`0`	`-pi`

- Why is it a good idea to construct more functions while composing a code script?
  - It is, in general, a good idea to write functions than hand computations as they are prone to human error.
  - Functions are separately implementable working pieces of a code. Hence, they form reusable blocks for future projects.
  - Usage of functions breaks the code into sections and allows adding more comments. Hence, the code becomes more readable.

- Are there any other code formatting techniques?
  - Finite-State Machines (Used in Mechatronics)
  - Object-Oriented Programming(Abstraction, Encapsulation, Inheritance, Polymorphism)