ASSIGNMENT - 1

Assignment 1 (Configuration Space, Parametrization, Task Space, Work Space, Degree of Freedom)

Note: Only handwritten answers are allowed

Due Date: 26/08/24 11:55 PM

Total Marks: 30

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1. Define the following and give an example for each to support the definition:
    a. Rigid body transformation
    b. Configuration Space
    c. Workspace
    d. Task Space
    e. Degree of Freedom

(1+1+1+1+1 marks)

2. a. Define Implicit and Explicit parametrization. Give the pros and cons of using explicit and implicit parametrizations.

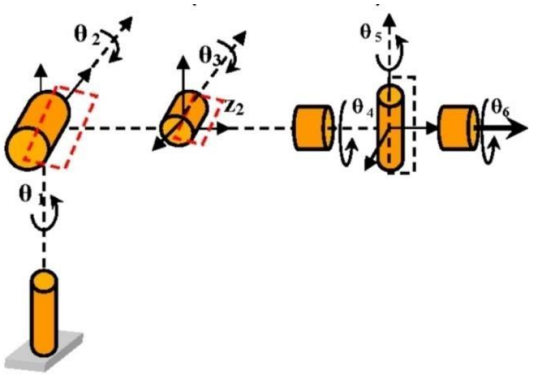
    b. Explain Coordinate singularity using appropriate pictures and expressions.

(2.5 + 2.5 marks)

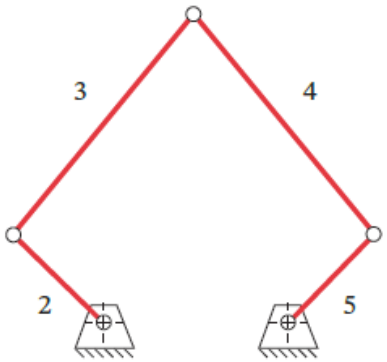
3. If the given 6R manipulator is being used to perform the task of cleaning a black board, then answer the following:

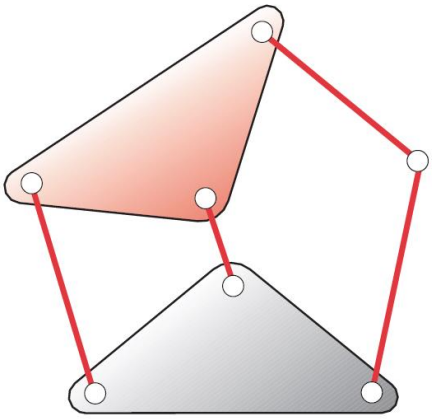
    a. Write the joint space variables
    b. Write the task space variables and give the topological representation in terms of $\mathbb{R}$ and $\mathbb{S}$.
    c. Write the work space variable and comment on the topology of the workspace for the given manipulator.

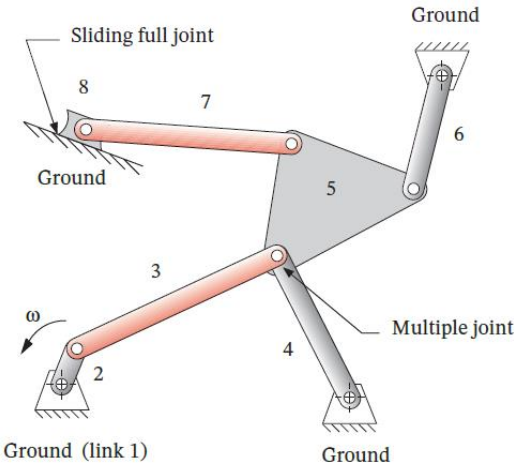
(1 + 2 + 2 marks)

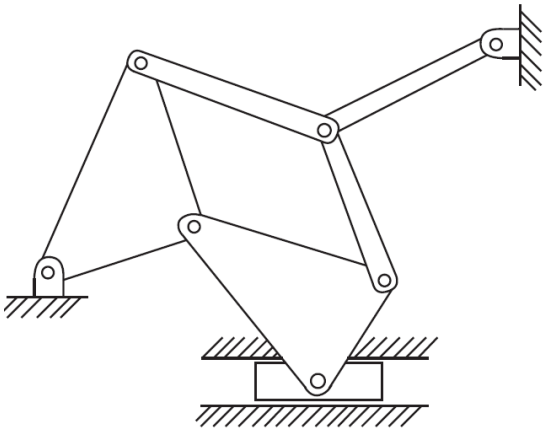


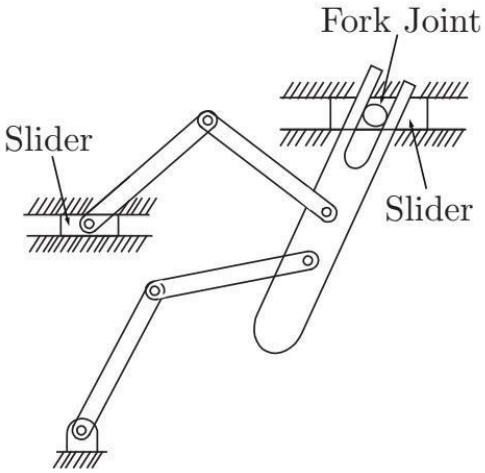
4. Find the Degree of Freedom for the Given Planar Mechanisms.





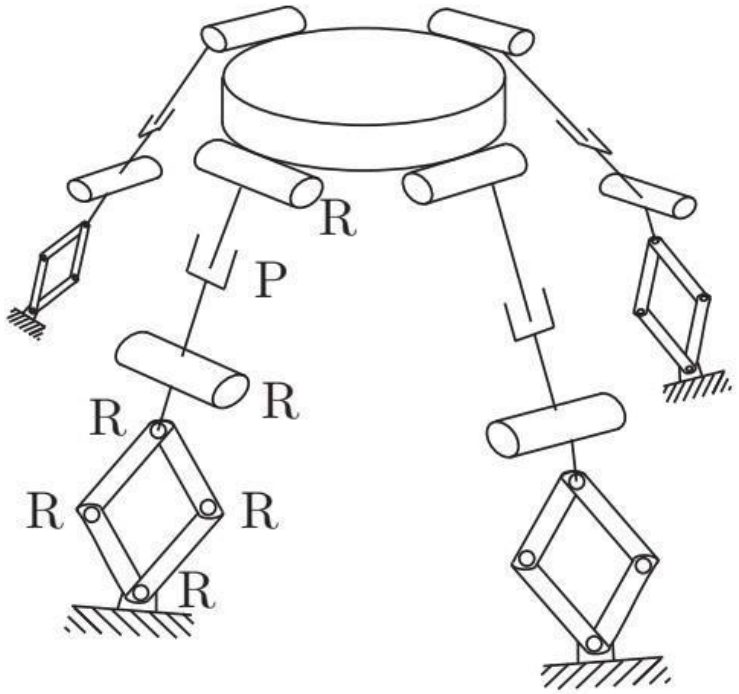






(1 + 1 + 1 + 1 + 1 marks)

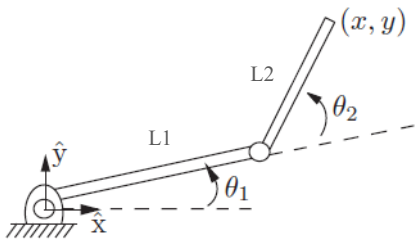
5. (a) Find the Degree of Freedom for the given mechanism:



(b) Calling each individual chain from ground to the central disk as leg, derive the Generalizes Equation for the Degree of Freedom of this mechanism using Grubler's formula for **n** legs.

(2.5+ 2.5 marks)

6.



The tip coordinates for the two-link planar of the given 2R robot are given by:

$$x = 2\cos\theta_1 + \cos(\theta_1 + \theta_2)$$
$$y = 2\sin\theta_1 + \sin(\theta_1 + \theta_2).$$

(a) What is the robot's configuration space?

(b) What is the robot's workspace (i.e., the set of all points reachable by the tip)? Also, sketch a rough diagram of its workspace.

(2.5 + 2.5 marks)