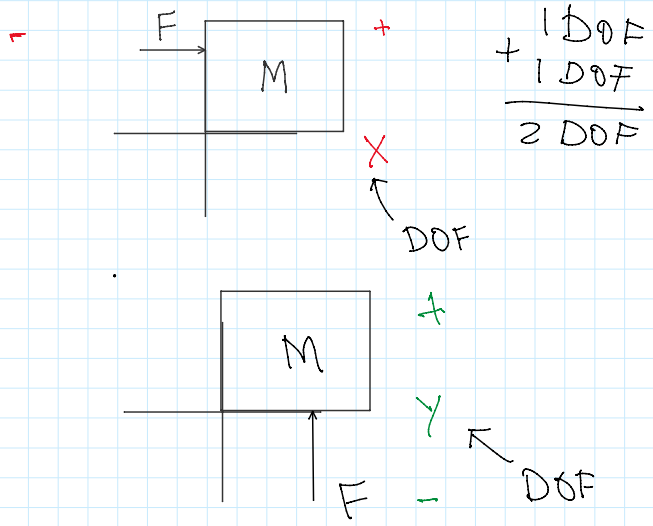
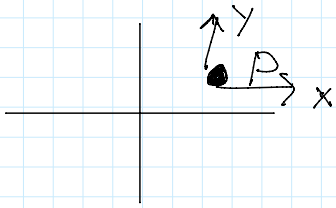
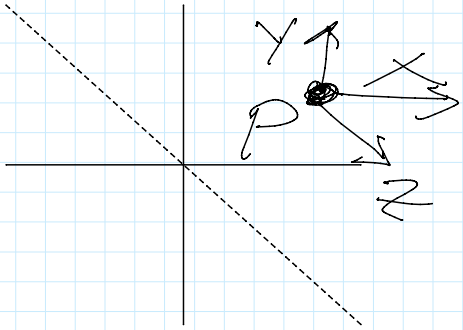
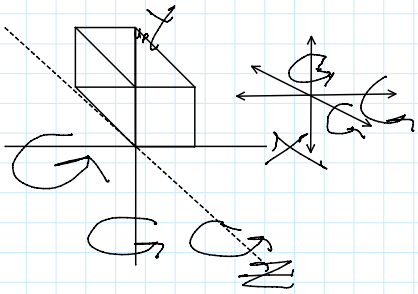
Degrees of Freedom

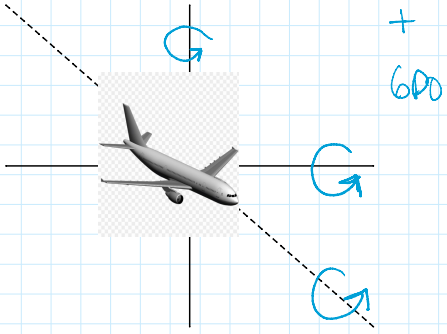
Monday, 29 August 2022 | 5:44 pm

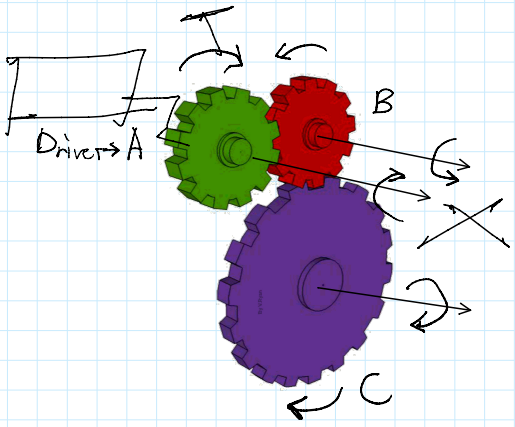




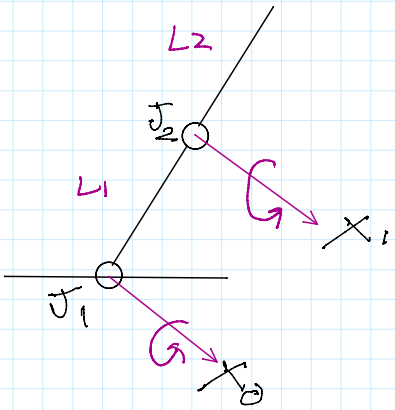




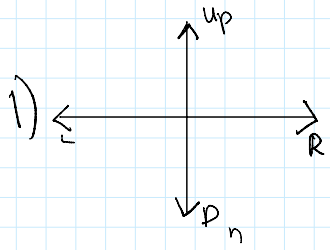




1 DOF



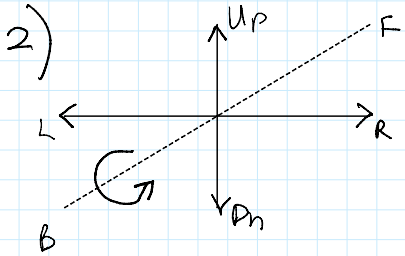
Importance of Under-actuated, Ideal and Redundant

1) 

2DOF

P

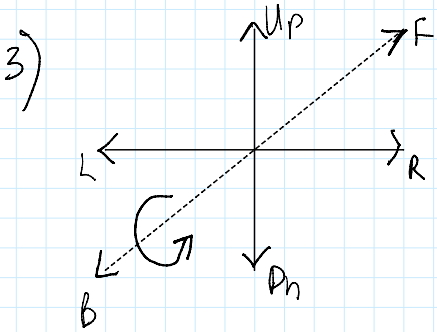
U.A.

2) 

3DOF

P

I

3) 

4DOF

P or S

R U.A.

Mobility/dof of Spatial Manipulator

Let us consider a manipulator with n rigid moving links and m joints

C_i: Connectivity of i-th joint; i = 1, 2, 3,....., m

No. of constraints put by i-th joint $= (6 - C_i)$

Total no. of constraints $= \sum_{i=1}^{m}(6 - C_i)$

Mobility of the manipulator $\mathbf{M = 6n - \sum_{i=1}^{m}(6 - C_i)}$

It is known as Grubler's criterion.

Mobility/dof of Planar Manipulator

Let us consider a manipulator with n rigid moving links and m joints

C_i: Connectivity of i-th joint; i = 1, 2, 3,....., m

No. of constraints put by i-th joint $= (3 - C_i)$

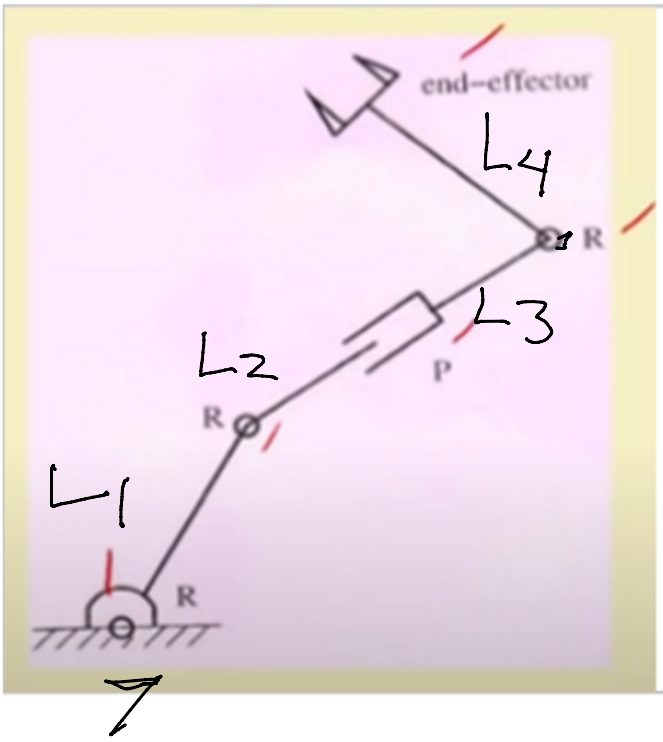
Total no. of constraints $= \sum_{i=1}^{m}(3 - C_i)$

Mobility of the manipulator $\mathbf{M = 3n - \sum_{i=1}^{m}(3 - C_i)}$

It is known as Grubler's criterion.

RRPR

Example 1: RRR Planar Manipulator



$m = 4$

$n = 4$

$R_1 = (3 - 1)$

$R_2 = (3 - 1)$

$P_3 = (3 - 1)$

$R_4 = (3 - 1)$

$$M = 3(4) - [2 + 2 + 2 + 2]$$

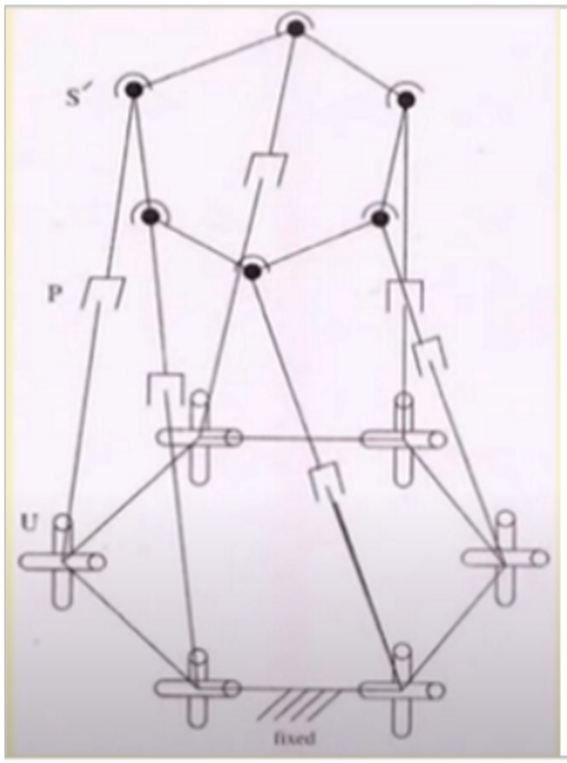
$$M = 12 - 8$$

$$M = 4$$

∴ This is a Redundant Planar Manipulator with Mobility of 4.

Example 2: Parallel Spatial Manipulator

Example 2: Parallel Spatial Manipulator



$m = 18$ EE

$n = 12 + 1 = 13$

$U_n = (6 - 2)$

$P_n = (6 - 1)$

$S_n = (6 - 3)$

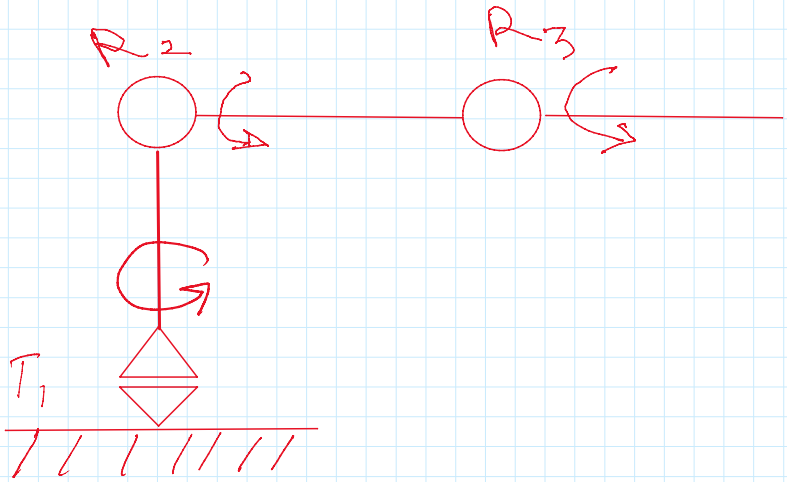
$$M = 6(13) - [6(2) + 6(5) + 6(3)]$$

$$M = 78 - [24 + 30 + 18]$$

$$M = 78 - 72$$

$$M = 6$$

This is an Ideal Spatial Manipulator with 6 DOF.



$$m = 3$$

$$n = 5$$

$$T_1 \text{ or } R_1 = (6-1)$$

$$R_2 = (6-1)$$

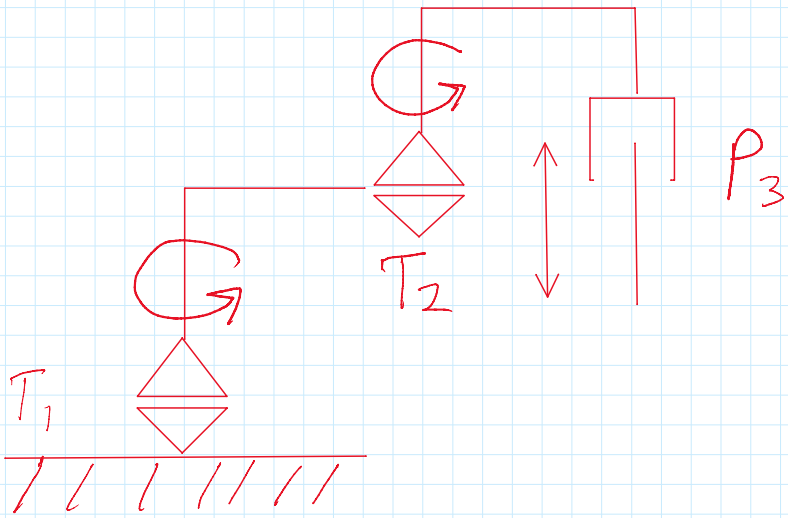
$$R_3 = (6-1)$$

$$M = 6(3) - [5+5+5]$$

$$M = 18 - 15$$

$$M = 3$$

- This is an Under Actuated Spatial Manipulator with 3 DOF.



$m = 3$
$n = 3$

- This is an Under Actuated Spatial Manipulator with 3 DOF.