Week 1. Robot Configuration Space.

* V0D2 Gruebler's formula for planar robots

: Gruebler's formula (planar version):

N = # of links (including ground)

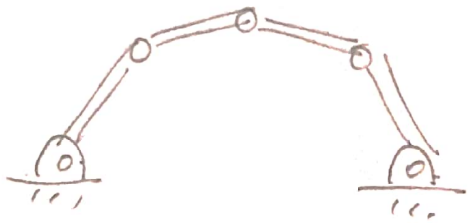
J = # of joints.

f_i = dof of joint i, $i = 1, \dots, J$

$$DOF = 3(N-1) - \sum_{i=1}^{J} (3 - f_i)$$

$$= 3(N-1-J) + \sum_{i=1}^{J} f_i$$

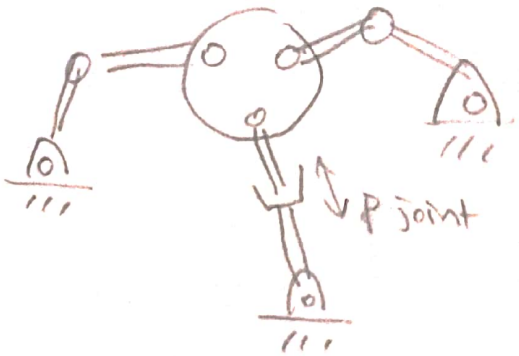
(ex).



$N = 5, \; J = 5. \; f_i = 1. \; \forall i$ (all i).

$DOF = 3(5-1-5) + 5 = 2$

(ex)

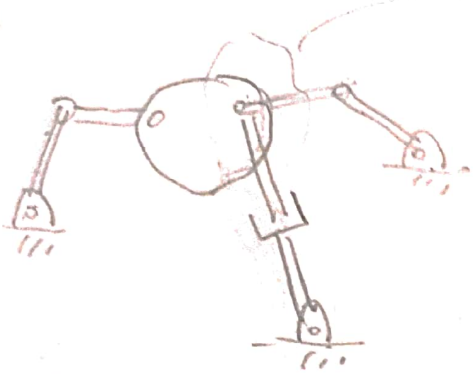


$N = 8. \; J = 9. \; f_i = 1.$

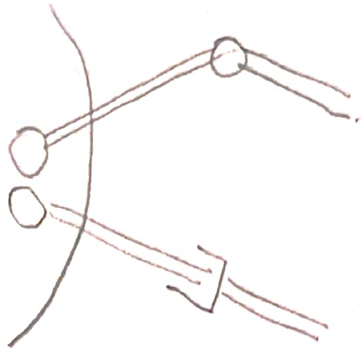
$DOF = 3(8-1-9) + 9$

$= 3$

(ex)



이렇게 되어야!



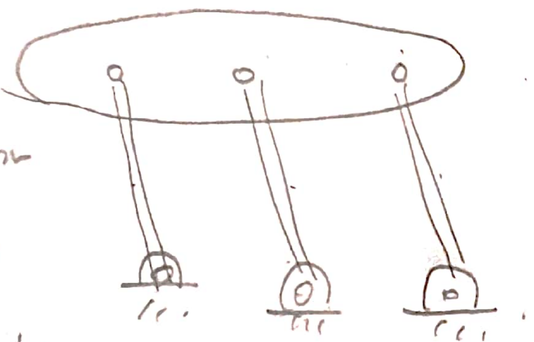
~~$N=8,\ J=8,\ f_1=1$~~

~~$DOF = 3(8-1-8)+8=5.$~~

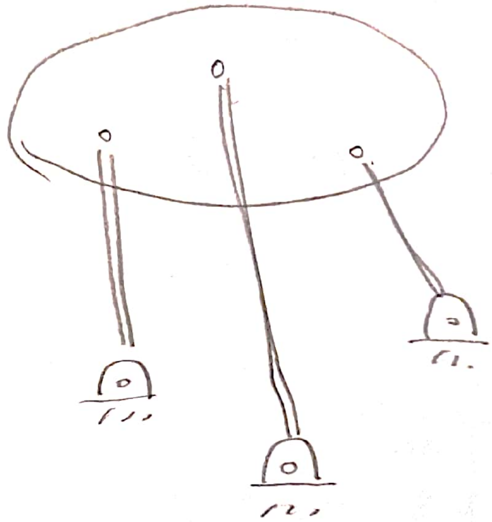
⇒ Every joint connects exactly two links!

(ex).

link의 길이가 모두 같은 예제!



↔



$N=5,\ J=6,\ f_1=1$

$DOF = 3(5-1-6)+6=0$ (?).

$DOF=0$.

※ There are some exceptions ※ to Gruebler's formula.

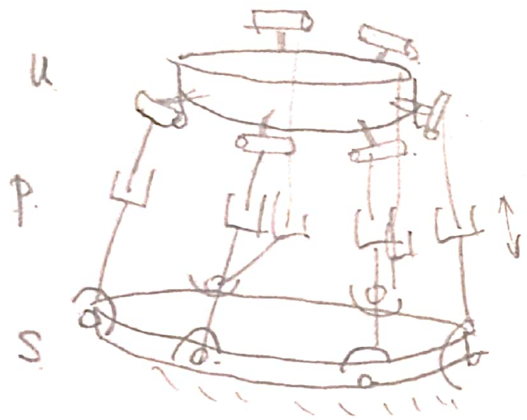
* Spatial Mechanism's (3D)

$$DOF = 6(N-1) - \sum_{i=1}^{J}(6-f_i)$$

↳ 3 position
  3 orientation

$$= 6(N-1-J) + \sum_{i=1}^{J} f_i$$

(ex) 6 x UPS platform:

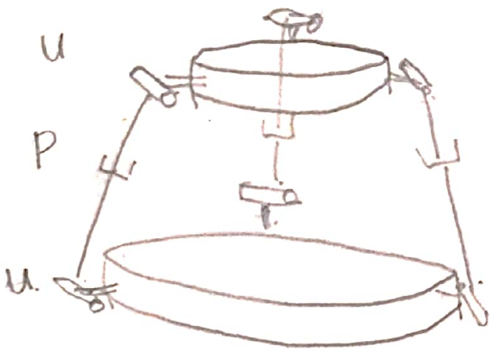


N = 14, J = 18.

f_i = { 6 S-joint (3x6)
  6 U - " (2x6)
  6 P-joint (1x6)

$$DOF = 6(14-1-18) + (18+12+6)$$
$$= 6$$ → P joint를 움직이는 것

(ex) 3 x UPU mechanism:



N = 8, J = 9

f_i = { 6 U-joint (2x6)
  3 P-joint (1x3)

$$DOF = 6(8-1-9) + (15)$$
$$= 3$$ → P joint를 움직이는 것

Actually, move like "5."
(Singular Mechanism).

↳ 이경우에는 공식과 다른 결과다
  더 많은 dof가 존재할 수 있다!