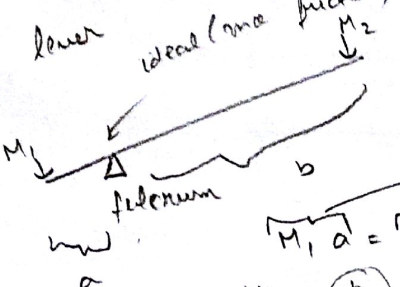
Functional Requirements	Design Parameters	Analysis	References	Risks	Countermeasur

manipulating
↳ rotating/twisting → [large objects [large bolts/nails, high gauge wires,]
bending — med. objects [med. nuts/bolts, med. gauge wire] decorative etc.
cutting — small objects [gas cylinder pins, cables/wires]
compressing
pulling
picking (jewelry/watches etc.)

lever

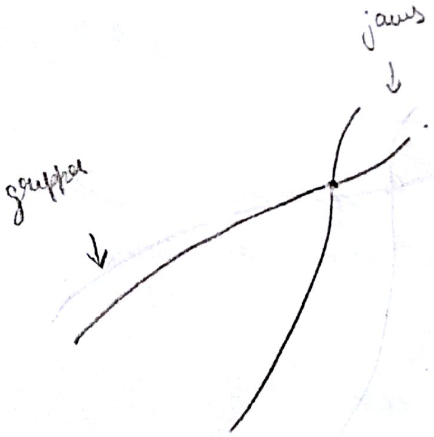


$$\overbrace{M_1 a = M_2 b}^{\text{Balanced moments}}$$

$$\frac{M_1}{M_2} = \underbrace{\frac{b}{a} > 1}_{\text{amplifying force}}$$

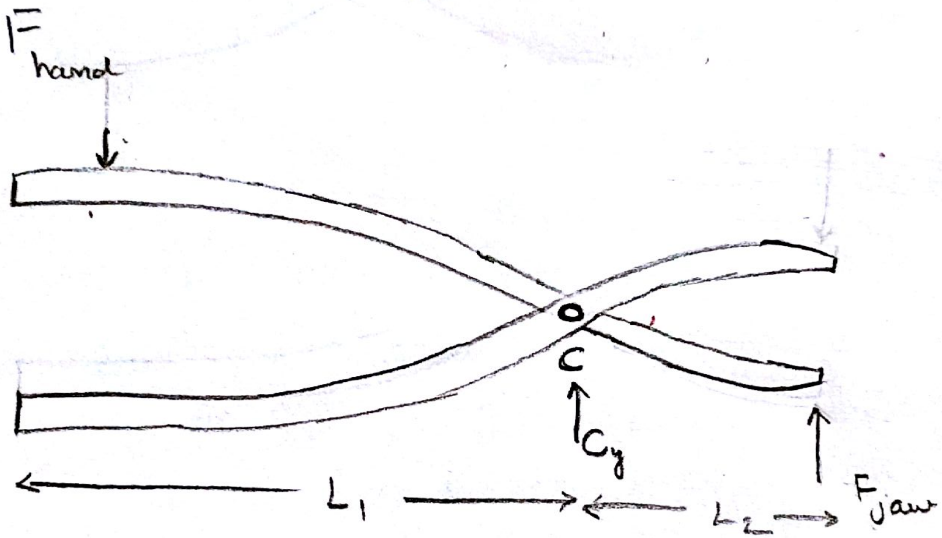
Moment → tendency of body to rotate about a specific point

② Pliers stick figure

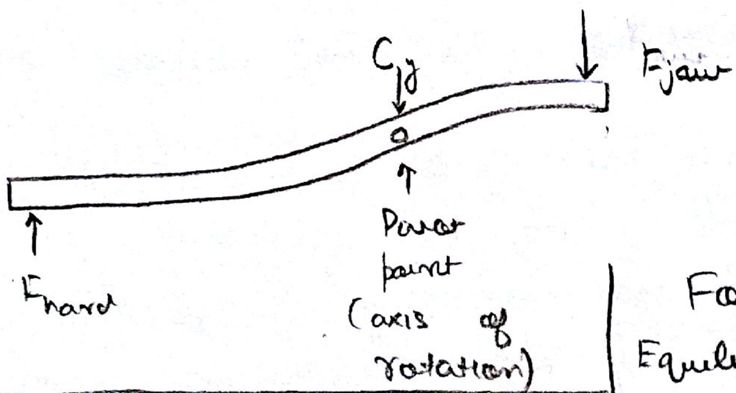


3 Free Body Diagram

The direction of Fjaw is downwards when gripping an object. As per the diagram the total force at pivot is Fhand - Fjaw.



4 Equations



Moment about pivot $= F_{hand} \times$ dist. (L_1)

Moment about pivot $= F_{jaw} \times$ dist

Force summation of equilibriums /

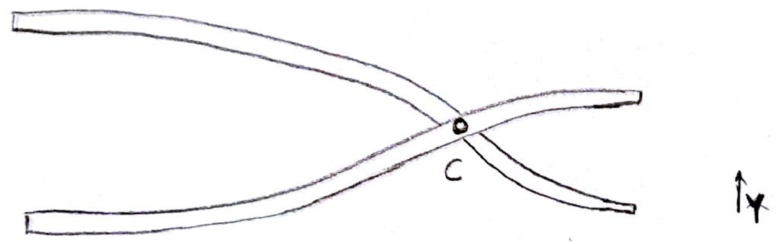
Equilibrium of moments (about pivot point)

$$F_{hand}(L_1) = F_{jaw}(L_2)$$

$$F_{jaw} = \frac{L_1}{L_2} \times F_{hand}$$

Force on pivot = $(F_{hand} + F_{jaw})$

What will the slider look like ? What forces are involved the slider design ?

5. 

Revolute joint (C) / Rivet

Problems that could arise at pin joint / C || Resolutions

→ Rivet could come lose if huge force is applied (over a long period of time) (wear and tear)

→ Friction b/w two grippers could increase (oiling should be done)

→ Rivet / C / Pin should be flushed during manufacturing along with ensuring no x/Z movement while moving grippers

→ Should be made of strong metal (forged steel / chromium) for the rivet or the gripper arms to not get distorted at the points where force is experienced. 1 DOF movement should be preserved.

6. → Inaccurate fit of rivet at the joint will make for wobbly tips that may not align, especially after long use

→ If the grippers are not manufactured with micron accuracy, those might not align after addition of joint.

→ If the gripper / plier joint metal is not strong, it might distort / bend after elongated use (gripper bars might bend) leading to non-alignment.

① Strategy → make multi-function lineman plier [CHOSEN] for FRDPARRC
→ make a single operation plier(bending plier, locking plier etc.)

Functional Requirements	Design Parameters	Analysis	References	Risks	Countermeasures
1. Manipulation Operations	Rotating / Twisting	→ Serrated jaws. 1 mm pitch	Analyzed current serrations on tool	Serrations might be destroyed	Laser hardening
	Cutting	→ Blade strength. [High carbon tool steel]	Wiki, Metal strengths book	Cost	Look for alloy if not molybdenum
	Bending	→ Min. dia bend restricted. Doesn't funcn as nose plier	Made for medium object's operation		
	Compressing	→ leverage eqn $\left[\frac{a}{b} \times M_1\right]$ where M is applied force	Freshman physics		
	Pulling	→ Pulling wire out of pipes. Narrow width of nose for clearance	wiki, real world usage		
2. Ergonomics / Ease of use.	Optimal Leverage	(a/b) × M_1, where M_1 is hand force			
	→ Increasing grip on handles	Rubber grippers	High density vulcanized rubber	Grippers might be destroyed	Object should still be polished and usable
	→ Range of motion	Non-adjustable. Restricted to 45°	Med. object can fit		
	→ Narrowing head/jaws for more detailed operations	3-5 mm thickness as opposed to 10 mm thickness of arm	Med. gauge wire thickness [Gauge chart]		
	→ Cutting blade shouldn't bend	High carbon tool steel	Strength of materials book	→ Might face abuse with stronger metals	→ Strengthen blade tips with laser
	→ Serrated front for better grip on object	1mm pitch	Current serration on real object	Cost	→ use stronger element or look at alloys
	→ Weight of pliers	Optimal length / leverage ratio	Made for med. objects. Doesn't have to be long like tongs.		
3. Durability	→ Arms / Jaws shouldn't bend after elongated use	High carbon tool steel	Strength of mat. book		
	→ Revolute joint should remain fixed after long use.	→ High carbon tool steel → Optimal fit to micron	'' YouTube - How to make pliers	Cost	→ Look at usage of High carbon steel alloy