



CIVIL ENGINEERING

Engineering Mechanics

Hand Notes For GATE, IES & PSUs

Hand Notes

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Note : We also providing GATE & IES Materials [Handnotes, Shortnotes & Books], All Reports [Seminar Reports & PPT]

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29/08/10

Simple Mechanism

Date 29/08/10

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Mechanical Engg.

Funda of Mechanics

Study of Motion

Kinematics

Study of Motion

 $\vec{r}_{ext}(x)$ Some eq:- \vec{s}

$$\frac{d\vec{s}}{dt} = \vec{v}$$

$$\frac{d\vec{v}}{dt} = \vec{a}$$

$$\frac{d\vec{a}}{dt} = \vec{y}$$

Dynamics

Study of motion

 $\vec{r}_{ext}(V)$

$$\vec{r}_{ext} = \frac{d}{dt}(m\vec{v}) \rightarrow \text{Newton's Second Law}$$

mass

measurement of Inertia

$$\mu \rightarrow \frac{N-s}{m} \text{ Dynamic Viscosity}$$

$$\nu \rightarrow \frac{m^2}{sec} \text{ Kinematic Viscosity}$$

KomSimple Mechanism:-

Kinematic Link:-

or, element

Every Part of a Machine which is having some relative motion with respect to some other Part is known as Kinematic link or element.

It is not necessary for the link to be perfectly rigid but it is necessary for the link to be a resistant body ^{so} that the power ~~or~~ motion can be transmitted.

Types of link:-

① Rigid link.

② flexible link.

③ fluid link.

Rigid :- deformation is negligible.

Flexible :- deformation is in permissible limit. eg:- belt, rope etc.

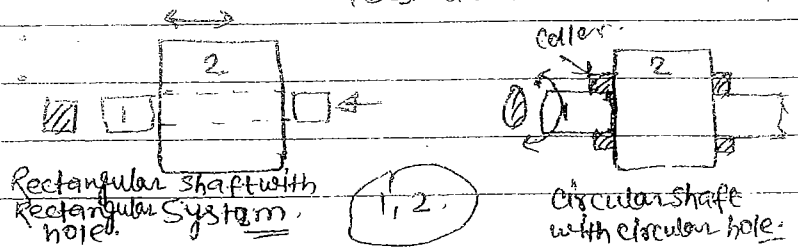
* Fluid :- When power is transmitted through the fluid pressure then fluid is known as fluid link.
eg:- all hydraulic devices.

Types of Relative motion:-

- ① Completely constrained motion:-] → constrained.
- ② Successfully constrained motion.]
- ③ Incompletely constrained motion.] → unconstrained.

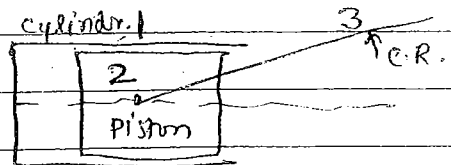
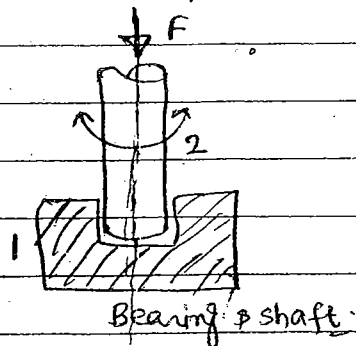
Constrained:- only one type of motion.

Completely :- self.



Successfully :- constrained with help of surrounding or other.

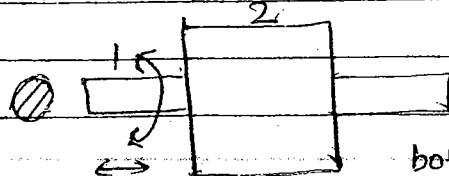
eg:- Piston/cylinder. →



Unconstrained:- undesired
↓
more than one are present.

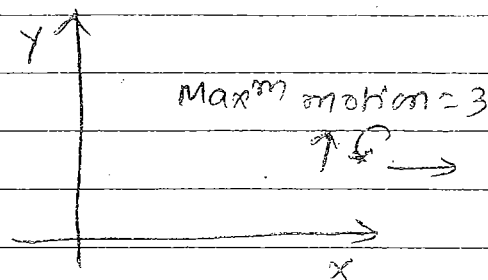
eg:-

Circular Shaft with Circular hole.



both rotation & reciprocating.

2D :- (Planar mechanism) :-



$$F = 3(l-1) - 2P_1 - 1P_2$$

No. of
Binary joints

No. of higher pairs

$$F = 3(l-1) - 2j - h \Rightarrow \text{Kutzbach eqn.}$$

Binary joint
higher pair

Grubler's equation :-

→ Mechanism with $F=1$, $h=0$.

$$\text{i.e., } 1 = 3(l-1) - 2j - h$$

$$\Rightarrow [3 - 4 - 2j = 0] \Rightarrow \text{Grubler's eqn.}$$

\downarrow even \downarrow even \downarrow even

Minimum No. of link required for Mechanism ($l_{\min} = 4$).

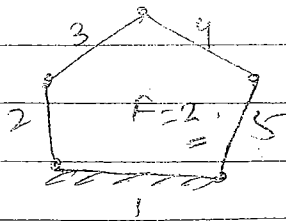
$F = 0 \rightarrow$ Frame.

$F < 0 \rightarrow$ super structure.

$F = 1 \rightarrow$ kinematic chain.

$\left. \begin{matrix} > 1 \\ 2 \\ 3 \end{matrix} \right\} \rightarrow$ unconstrained chain.

##



→ How to give the Constraint motion with unconstraint chain.

⇒ No. of Input required to give the Constraint motion = No. of DOF.

Degree of freedom is the No. of required input to give the desired Constraint output.

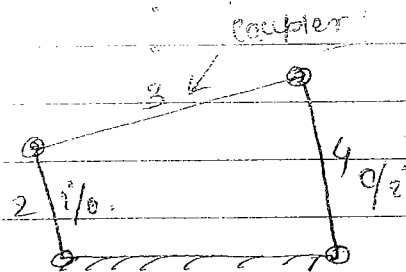
Four bar mechanism:- (4 links connected by four turning pair)

or Quadric cycle:-

(4 link + 4TP)

→ When the 4 links are connected by four turning pairs then the mechanism is known as four bar mechanism.

→ Second name is quadric cycle.



↑ frame or, fixed link.

→ adjacent link → input or, output.

→ Connecting of adjacent link is known as Coupler.

i/o : → Rotate → Crank
→ Oscillation → Rocker or, Lever.

Inversion:-

① Double Crank or, Crank-Crank.

② Crank Rocker, or, Rocker Crank.

③ Rocker-Rocker or, Double Rocker.

Kinematic Pair:-

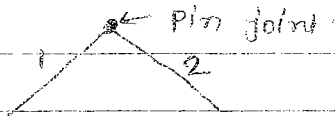
The connection between two links is always joint or a pair. But this pair will be a kinematic pair if the relative motion between them is a constrained motion.

Classification of kinematic pairs:-

① A/c to the type of relative motion there are five types of kinematic pairs:-

- ① Turning pair or (Revolute pair)
- ② Sliding pair or (Prismatic pair)
- ③ Rolling pair or
- ④ Screw pair
- ⑤ Spherical pair

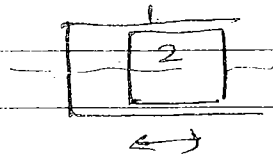
→ when relative motion is pure turning then turning pair



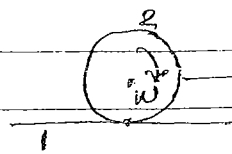
eg:- wrist pin, crank pin etc

→ when relative motion is purely ~~sliding~~ ^{sliding} the sliding pair.

eg:- Piston inside the cylinder.



→ when relative motion is purely rolling without skidding



eg:- Ball bearing.

Velocity of centre of mass is directly dependent on rolling (ω) and is independent parameter.

$V_{c.m.} = R\omega$

↑ dependent motion, ↑ independent motion

→ when relative motion is purely screw thread motion.

eg:- Lead in nut & bolt.