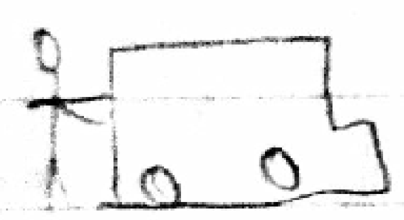
Chapter 3: Statics of Rigid bodies

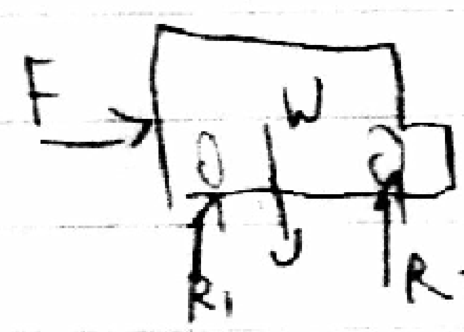
Objectives: understand forces on Rigid bodies
- Replace a given system and force with an equivalent force
- Find the state of equilibrium

3.1 Rigid body definition

The dimensions of the object and the point of application of the force must be considered



FBD →



* internal and External forces are important (we don't need internal force on FBD)

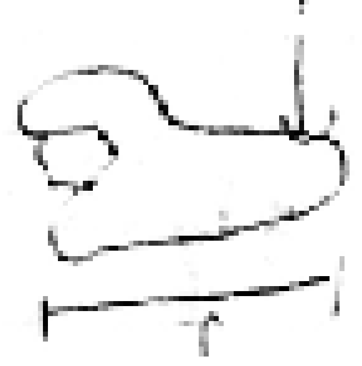
3.2.1 External + Internal forces

3.2.2 Principle of Transmissibility - Equivalent force

Def: Replacing $\vec{F}$ by $\vec{F'}$ acting in the same direction with the same magnitude, but acting at a different point. By doing this, conditions of equilibrium or motion are not affected

3.2.3 moments

A moment is a mesurment of how much a force acting on a rigid body causing rotation

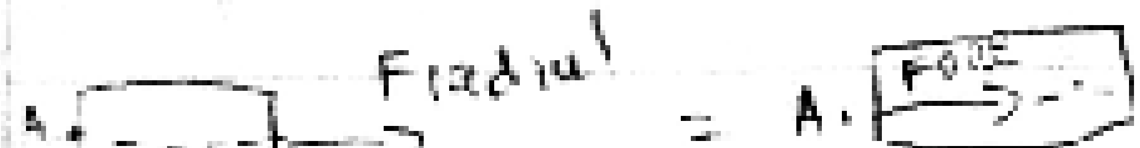


$M = rF$ units are Nm
$= \vec{r} \times \vec{F}$

3.2.4 moments of a force about a point

$\vec{M}_A = \vec{r} \times \vec{F}$

in order to create a moment, you need a force and a distance



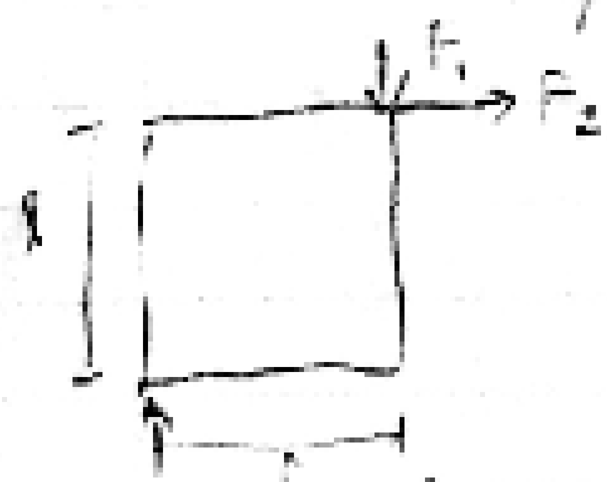
no distance between F radial and A
$r = 0 \rightarrow m = 0$

2D

[3.2.4.1 shortcut ; otherwise you have to do the cross product

$M = r F_{perpendicular}$

(+) $M_A = |F_1 r + F_2 h|$

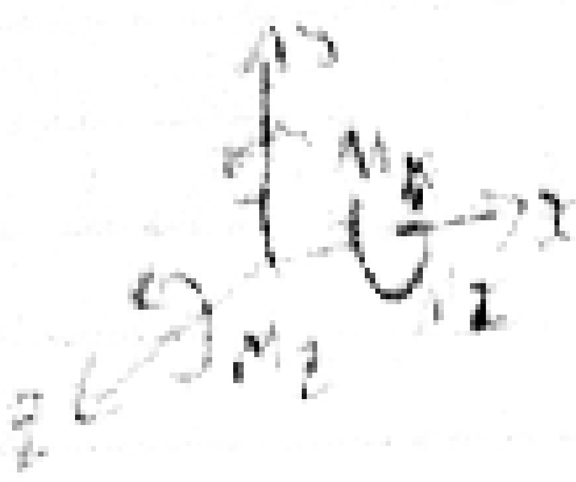


3D → no shortcut, apply cross product

crossproduct $\vec{M_0} = \vec{r} \times \vec{F}$

$\vec{r} = r_x\hat{i} + r_y\hat{j} + r_z\hat{k}$ $\quad$ $\vec{F} = F_x\hat{i} + F_y\hat{j} + F_z\hat{k}$

$\vec{M_0} = M_x\hat{i} + M_y\hat{j} + M_z\hat{k}$



right hand rule

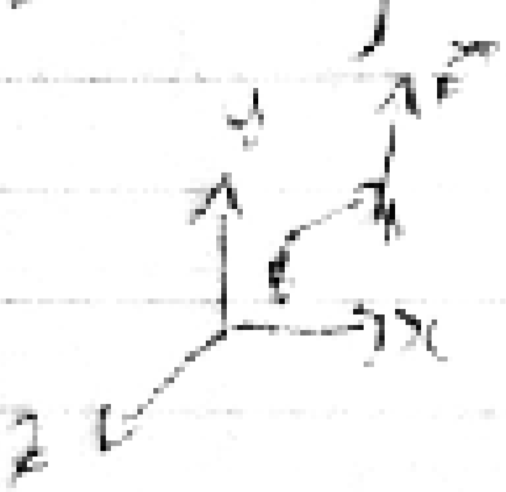
$\vec{r} = (r_yF_z - r_zF_y)\hat{i} - (r_xF_z - r_zF_x)\hat{j} + (r_xF_y - r_yF_x)\hat{k}$

$M_x = r_yF_z - r_zF_y$

$M_y = -(r_xF_z - r_zF_x)$

$M_z = r_xF_y - r_yF_x$

3.2.2 moments about another point, other than the origin



$\vec{M_B} = \vec{r} \times \vec{F}$

$= \vec{r}_{A/B} \times \vec{F}$

$x_{AB} = x_A - x_B$

$y_{AB} = y_A - y_B$

$z_{AB} = z_A - z_B$

3.2.5 varigons principle

$\vec{r} \times (\vec{F_1} + \vec{F_2} + \dots) = \vec{r} \times F_1 + \vec{r} \times F_2 \dots$