Body Fixd Coordinctes

$\begin{array}{llll}\text { coordinate axas } & x & y & z \\ \text { wail vecturs } & \hat{i} & \hat{j} & \hat{k}\end{array}$
components of vel $U$ W
compornants of ang. p $q \quad r$
vel
net force X I M,
net torqu/moment $L M W$

$$
\begin{aligned}
& \bar{V}=U \hat{\imath}+V \hat{\jmath}+W \hat{k} \\
& \bar{\omega}=p \hat{v}+q \hat{\jmath}+r \hat{k} \\
& {[v]=\left[\begin{array}{c}
u \\
v \\
w
\end{array}\right] \quad[\omega]=\left[\begin{array}{l}
p \\
q \\
r
\end{array}\right]}
\end{aligned}
$$

$$
\begin{aligned}
& \bar{F}=m \bar{a} \\
& \bar{a}=\frac{d \bar{v}}{d t} \\
& {\left[\begin{array}{c}
X \\
\frac{X}{V} \\
Z
\end{array}\right]=m \frac{d}{d t}\left[\begin{array}{l}
V \\
u \\
w
\end{array}\right]} \\
& \text { ang. momatm inerth madrix } \\
& {[\tau]=\frac{d\left[A_{c}\right]}{d t}}
\end{aligned}
$$

Newton's secord
Euler equation
inerts

Eoms
Newtuns Second Law

$$
\bar{F}=\frac{d \bar{P}}{d t}=m \bar{a}
$$

$$
I_{x x}=\int\left(y^{2}+z^{2}\right) d m
$$

$$
\operatorname{L}^{L x y}=-\int(x y) d m
$$



$$
\frac{d \bar{v}}{d t}=
$$

1 -

$$
d t
$$

$$
\left.\frac{d \bar{v}}{d t}\right|_{r_{1} \mid}=\frac{d}{d t_{r .1}}\left(u_{\hat{\imath}}+v_{\hat{\jmath}}+w_{\hat{k}}\right)
$$

$$
=\dot{u} \hat{u}+\dot{v} \hat{\jmath}+\dot{\omega} \hat{k}
$$

$$
\bar{\omega} \times \bar{v}=(p \hat{\imath}+\varepsilon \hat{\jmath}+r \hat{k}) \times\left(u_{\hat{\imath}}+v_{j}+w \hat{k}\right)
$$

$$
\left|\begin{array}{lll}
i & j & K \\
p & q & r \\
u & v & w
\end{array}\right|=\left[\begin{array}{c}
q w-r V \\
-(p w-r u) \\
p V-q U
\end{array}\right]
$$

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$$
\frac{d\left[H_{0}\right]^{t^{3 \times 1}}}{d t}=\frac{d\left[I_{c}\right][\omega]}{d t}=\left.\frac{d\left[H_{c}\right]}{d t}\right|_{r a 1}+[\bar{u}] \times\left[H_{c}\right]
$$

inertial
$[\tau] \frac{d\left[H_{c}\right]}{d t}$

planar object has

$$
I_{z z}, \Sigma_{x y}
$$ only

$$
\begin{aligned}
& \bar{F}=\frac{d r}{d t}=m \bar{a}
\end{aligned}
$$

$$
\begin{aligned}
& {\left[H_{c}\right]=\left[\begin{array}{lll}
I_{x x} & I_{x y} & I_{x z} \\
I_{x y} & I_{y y} & I_{y z} \\
I_{x z} & I_{y z} & I_{z z}
\end{array}\right]\left[\begin{array}{l}
p \\
q \\
r
\end{array}\right]=\left[\begin{array}{l}
I_{x x} p+I_{x y} q+I_{x z} r \\
I_{x y} P+I_{y y} q+I_{y z} r \\
I_{x z} p+I_{y z} q+I_{z z} r
\end{array}\right]} \\
& \left.\frac{d\left(H_{c}\right)}{d t}\right|_{r e l}=\left[\begin{array}{l}
I_{x x} \dot{p}+I_{x y} \dot{q}+I_{x z} \dot{r} \\
I_{x y} \dot{p}+I_{y y} \dot{q}+I_{y z} \dot{r} \\
I_{x z} \dot{p}+I_{y z} \dot{q}+I_{z z \dot{r}}
\end{array}\right] \\
& \bar{C} \times \bar{H}_{c}=\left[\begin{array}{l}
q\left(I_{z x p}+I_{z y} q+I_{z z} r\right)-r\left(I_{y x} p+I_{y y} q+I_{y z} r\right) \\
r\left(I_{x x p}+I_{x y q}+I_{x z} r\right)-p\left(I_{z x p}+I_{z y q}+I_{z z} r\right) \\
p\left(I_{y x} p+I_{y y q} q+I_{y z r}\right)-q\left(I_{x x p}+I_{x y} q+I_{x z} r\right)
\end{array}\right]
\end{aligned}
$$

see 2119

