2.6 $\bar{V} = u\bar{i}_h - w\bar{k}_h \qquad V = \sqrt{u^2+w^2} \qquad \tan\gamma = \frac{w}{u}$

$\bar{V} = \frac{d\bar{E}_0}{dt} \qquad \bar{E}_0 = x\bar{i}_h - h\bar{k}_h \qquad \frac{d\bar{E}_0}{dt} = \dot{x}\bar{i}_h - \dot{h}\bar{k}_h$

①, ② $\bar{V} = u\bar{i}_h - w\bar{k}_h \Rightarrow \qquad \dot{x} = u, \quad \dot{h} = w$

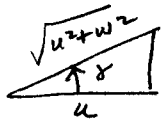
$\bar{F} = m\bar{a} \qquad \bar{a} = \frac{d\bar{V}}{dt} \qquad \bar{a} = \dot{u}\bar{i}_h - \dot{w}\bar{k}_h$

From Fig. 2.2

$$\bar{F} = T\cos(\varepsilon+\gamma)\bar{i}_h - T\sin(\varepsilon+\gamma)\bar{k}_h - L\sin\gamma\,\bar{i}_h - L\cos\gamma\,\bar{k}_h$$
$$- D\cos\gamma\,\bar{i}_h + D\sin\gamma\,\bar{k}_h + W\bar{k}_h$$

$$\dot{u} = (W/g)\left[T\cos(\varepsilon+\gamma) - L\sin\gamma - D\sin\gamma\right]$$
$$\dot{w} = (W/g)\left[T\sin(\varepsilon+\gamma) + L\cos\gamma - D\sin\gamma - W\right]$$

$\cos(\varepsilon+\gamma) = \cos\varepsilon\cos\gamma - \sin\varepsilon\sin\gamma, \quad \sin(\varepsilon+\gamma) = \sin\varepsilon\cos\gamma + \cos\varepsilon\sin\gamma$

$\tan\gamma = \frac{w}{u}$ 

$\sin\gamma = \frac{w}{\sqrt{u^2+w^2}}, \quad \cos\gamma = \frac{u}{\sqrt{u^2+w^2}}$

③ $\dot{u} = (W/g)\left[\left(T\cos\varepsilon - D\right)\frac{u}{\sqrt{u^2+w^2}} - \left(T\sin\varepsilon + L\right)\frac{w}{\sqrt{u^2+w^2}}\right]$

④ $\dot{w} = (W/g)\left[\left(T\cos\varepsilon - D\right)\frac{w}{\sqrt{u^2+w^2}} + \left(T\sin\varepsilon + L\right)\frac{u}{\sqrt{u^2+w^2}} - W\right]$

⑤ $\dot{W} = -cT$

where $\varepsilon = \varepsilon_0 + \alpha$

a. mdof

$L(h, V, \alpha) \rightarrow$	$L(h, u, w, \alpha)$
$D(h, V, \alpha)$	$D(h, u, w, \alpha)$
$T(h, V, P)$	$T(h, u, w, P)$
$C(h, V, P)$	$C(h, u, w, P)$

variables x, h, u, w, W, P, α 7 var − 5 eqns = 2 mdof

2.6 Cont'd

b. $u = V\cos\gamma \Rightarrow \dot{u} = \dot{V}\cos\gamma - V\sin\gamma\,\dot{\gamma}$

$w = V\sin\gamma \quad \dot{w} = \dot{V}\sin\gamma + V\cos\gamma\,\dot{\gamma}$

$$\frac{u}{\sqrt{u^2+w^2}} = \cos\gamma, \quad \frac{w}{\sqrt{a^2+b^2}} = \sin\gamma$$

Eqs. ③ and ④ become 2 eqns in 2 unkns $\dot{V}$ and $\dot{\gamma}$

They can be solved by elimination - requires a lot of algebra

Or Mult. ③ by $\cos\gamma$ and ④ by $\sin\gamma$
and add the two results to get $\dot{V}$

Mult ③ by $\sin\gamma$ and ④ by $\cos\gamma$
and subtract the results to get $\dot{\gamma}$

This process leads to Eqs. 2.24.