Behavioral model

1. $L_{wing} = C_{L_{wing}} \frac{1}{2} \rho V^2 S_{wing}$
2. $L_{horizontal\ tail} = C_{L_{horizontal\ tail}} \frac{1}{2} \rho V^2 S_{horizontal\ tail}$
3. $D_{vertical\ tail} = \frac{1}{2} \rho V^2 C_{D_{vertical\ tail}} A_{vertical\ tail}$
4. $D_{horizontal\ tail} = \frac{1}{2} \rho V^2 C_{D_{horizontal\ tail}} A_{horizontal\ tail}$
5. $D_{fuselage} = \frac{1}{2} \rho V^2 C_{D_{fuselage}} A_{fuselage}$
6. $D_{landing\ gear} = \frac{1}{2} \rho V^2 C_{D_{landing\ gear}} A_{landing\ gear}$
7. $D_{wing} = \frac{1}{2} \rho V^2 C_{D_{wing}} A_{wing}$
8. $D_{left\ engine} = \frac{1}{2} \rho V^2 C_{D_{left\ engine}} A_{left\ engine}$
9. $D_{right\ engine} = \frac{1}{2} \rho V^2 C_{D_{right\ engine}} A_{right\ engine}$
10. $D_i = \frac{(L_{wing} + L_{horizontal\ tail})^2}{0.5 \pi \rho V^2 b^2 e}$
11. $M_0 = \frac{V}{\sqrt{\gamma R T_0}}$
12. $T_{t_0} = T_0 \left(1 + \frac{\gamma - 1}{2} M_0^2\right)$
13. $\theta_0 = \frac{T_{t_0}}{T_0}$
14. $\theta_{T,right\ engine} = \frac{T_{t_0} \tau_{b,right\ engine} \tau_{c,right\ engine} \tau_{d,right\ engine}}{T_0}$
15. $T_{right\ engine} = m^{dot} \sqrt{\gamma R T_0} \left(\sqrt{\frac{2\theta_0}{\gamma - 1} \left(\frac{\theta_{T,right\ engine}}{\theta_0 \tau_{c,right\ engine}} - 1 \right) \left(\tau_{c,right\ engine} - 1 \right) + \frac{\theta_{T,right\ engine} M_0^2}{\theta_0 \tau_{c,right\ engine}}} - M_0 \right)$
16. $\theta_{T,left\ engine} = \frac{T_{t_0} \tau_{b,left\ engine} \tau_{c,left\ engine} \tau_{d,left\ engine}}{T_0}$
17. $T_{left\ engine} = m^{dot} \sqrt{\gamma R T_0} \left(\sqrt{\frac{2\theta_0}{\gamma - 1} \left(\frac{\theta_{T,left\ engine}}{\theta_0 \tau_{c,left\ engine}} - 1 \right) \left(\tau_{c,left\ engine} - 1 \right) + \frac{\theta_{T,left\ engine} M_0^2}{\theta_0 \tau_{c,left\ engine}}} - M_0 \right)$
18. $T_{right\ engine} + T_{left\ engine} = D_{vertical\ tail} + D_{horizontal\ tail} + D_{fuselage} + D_{landing\ gear} + D_{wing} + D_{left\ engine} + D_{right\ engine} + D_i$
19. $L_{wing} + L_{horizontal\ tail} = w_{vertical\ tail} + w_{horizontal\ tail} + w_{fuselage} + w_{landing\ gear} + w_{wing} + w_{left\ engine} \cdots$
$+ w_{right\ engine} + w_{fuel}$
20. $w_{vertical\ tail} = \rho_{vertical\ tail} v_{vertical\ tail}$
21. $w_{horizontal\ tail} = \rho_{horizontal\ tail} v_{horizontal\ tail}$
22. $w_{fuselage} = \rho_{fuselage} v_{fuselage}$
23. $w_{landing\ gear} = \rho_{landing\ gear} v_{landing\ gear}$
24. $w_{wing} = \rho_{wing} v_{wing}$
25. $w_{left\ engine} = \rho_{left\ engine} v_{left\ engine}$
26. $w_{right\ engine} = \rho_{right\ engine} v_{right\ engine}$
27. $w_{fuel} = \rho_{fuel} v_{fuel}$
28. $v_{vertical\ tail} = A_{vertical\ tail} b_{vertical\ tail}$
29. $v_{horizontal\ tail} = A_{horizontal\ tail} b_{horizontal\ tail}$
30. $v_{wing} = \frac{S_{wing} A_{wing}}{b}$
31. $\delta = \frac{N\left(w_{fuselage} + w_{landing\ gear} + w_{left\ engine} + w_{right\ engine} + w_{cargo} + w_{horizontal\ tail} + w_{vertical\ tail} + w_{fuel}\right)}{EI} \frac{b^3}{64}$
32. $I = \frac{t^3 c}{12}$
33. $S_{wing} = \frac{c\, b}{2}$
34. $A_{wing} = \frac{tb}{2}$

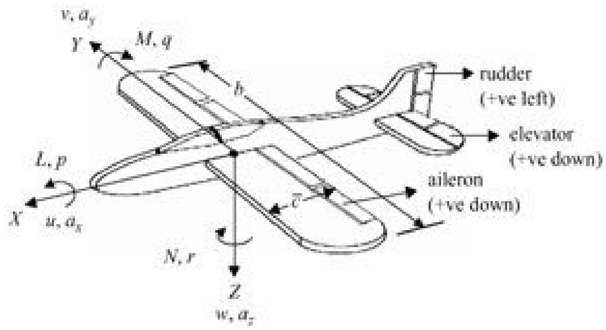

Fig. 1 Aircraft axes

Please refer to Fig. 1 for information on axes. For instance, aircraft dimensions in the parameter descriptions are given with respect to the x, y, and z axes shown in Fig. 1. Motion about the x axis would be roll, motion about the y axis would be pitch, and motion about the z axis would be yaw.

Table 1. Aircraft model parameter descriptions

$A_{fuselage}$	Frontal area of fuselage (YZ axis)	t	Thickness of wing	c	Chord length of wing
$A_{horizontal\ tail}$	Frontal area of horizontal tail (YZ axis)	e	Wing efficiency factor	$w_{landing\ gear}$	Weight of landing gear
$A_{landing\ gear}$	Frontal area of landing gear (YZ axis)	$L_{horizontal\ tail}$	Lift generated by horizontal tail	$w_{left\ engine}$	Weight of left engine
$A_{left\ engine}$	Frontal area of left engine (YZ axis)	L_{wing}	Lift generated by wing	$w_{right\ engine}$	Weight of right engine
$A_{right\ engine}$	Frontal area of right engine (YZ axis)	m^{dot}	Mass flow rate of air entering engines	$w_{vertical\ tail}$	Weight of vertical tail
$A_{vertical\ tail}$	Frontal area of vertical tail (YZ axis)	M_0	Freestream Mach number	w_{wing}	Weight of wing
A_{wing}	Frontal area of wing (YZ axis)	R	Gas constant	γ	Specific heat ratio for air
b	Wingspan (Y axis)	$S_{horizontal\ tail}$	Planform area of horizontal tail (XY axis)	$\theta_{T,left\ engine}$	Stagnation-static temperature ratio for left engine turbine inlet
$b_{horizontal\ tail}$	Span of horizontal tail (Y axis)	S_{wing}	Planform area of wing (XY axis)	$\theta_{T,right\ engine}$	Stagnation-static temperature ratio for right engine turbine inlet
$b_{vertical\ tail}$	Span of vertical tail (Z axis)	$T_{left\ engine}$	Thrust generated by left engine	θ_0	Stagnation-static temperature ratio for freestream air
$C_{D_{fuselage}}$	Drag coefficient of fuselage	$T_{right\ engine}$	Thrust generated by right engine	ρ	Air density
$C_{D_{horizontal\ tail}}$	Drag coefficient of horizontal tail	T_{t_0}	Freestream stagnation air temperature	ρ_{fuel}	Density of fuel
$C_{D_{landing\ gear}}$	Drag coefficient of landing gear	T_0	Freestream air temperature	$\rho_{fuselage}$	Density of material of fuselage
$C_{D_{left\ engine}}$	Drag coefficient of left engine	V	Airspeed	$\rho_{horizontal\ tail}$	Density of material of horizontal tail
$C_{D_{right\ engine}}$	Drag coefficient of right engine	v_{fuel}	Volume of fuel	$\rho_{landing\ gear}$	Density of material of landing gear
$C_{D_{vertical\ tail}}$	Drag coefficient of vertical tail	$v_{fuselage}$	Volume of fuselage	$\rho_{left\ engine}$	Density of material of left engine
$C_{D_{wing}}$	Drag coefficient of wing	$v_{horizontal\ tail}$	Volume of horizontal tail	$\rho_{right\ engine}$	Density of material of right engine

$C_{L_{horizontal\ tail}}$	Lift coefficient of horizontal tail	$v_{landing\ gear}$	Volume of landing gear	$\rho_{vertical\ tail}$	Density of material of vertical tail
$C_{L_{wing}}$	Lift coefficient of wing	$v_{left\ engine}$	Volume of left engine	ρ_{wing}	Density of material of wing
$D_{fuselage}$	Drag generated by fuselage	$v_{right\ engine}$	Volume of right engine	$\tau_{b,left\ engine}$	Temperature ratio of combustion chamber in left engine
$D_{horizontal\ ta}$	Drag generated by horizontal tail	$v_{vertical\ tail}$	Volume of vertical tail	$\tau_{b,right\ engine}$	Temperature ratio of combustion chamber in right engine
D_i	Drag induced by lift	v_{wing}	Volume of wing	$\tau_{c,left\ engine}$	Temperature ratio of compressor in left engine
$D_{landing\ gear}$	Drag generated by landing gear	w_{bag}	Average weight of a single bag	$\tau_{c,right\ engine}$	Temperature ratio of compressor in right engine
$D_{left\ engine}$	Drag generated by left engine	w_{cargo}	Weight of cargo	$\tau_{d,left\ engine}$	Temperature ratio of inlet in left engine
$D_{right\ engine}$	Drag of right engine	w_{fuel}	Weight of fuel	$\tau_{d,right\ engine}$	Temperature ratio of inlet in right engine
$D_{vertical\ tail}$	Drag generated by vertical tail	$w_{fuselage}$	Weight of fuselage	δ	Wing tip deflection
D_{wing}	Drag generated by wing	$w_{horizontal\ ta}$	Weight of horizontal tail	E	Young’s modulus of wing
N	Load factor	I	Moment of inertia of wing		