

DESIGN, ANALYSIS AND RESEARCH CORPORATION

ERRATA: AIRPLANE DESIGN PART I

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(Revised June 11, 1997)

<i>page 51, Eqn. (2.9)</i>	units for c_p = (lbs/hr)/hp
<i>line 6 from bottom</i>	replace 1,000 nm with 1,000 sm
<i>page 52, line 3</i>	1000 is standard miles
<i>page 61, Table 2.19</i>	Take-off and Landing: groundrun of less than 2,400 ft.
<i>page 64, line 3 and 5</i>	W is the take-off weight: W_{TO}
<i>page 69, Eqn. (2.23)</i>	$D = (W_{PL} + W_{CREW}) + W_{p_{exp}}$ Where $W_{p_{exp}}$ is the weight of the expended payload. (i.e., Missiles, bombs, etc.)
<i>page 95, line 14 from bottom</i>	remove “range of”
<i>page 98, line 8 from bottom</i>	replace $C_{L_{TO_{max}}}$ by $C_{L_{max_{TO}}}$
<i>page 106, line 2</i>	replace four factors: with five factors:
<i>page 115, Eqn. (3.18)</i>	$V_A = 1.1 V_{s_{PA}}$
<i>page 132, 4th line</i>	delete “an”
<i>page 150, Eqn. (3.32)</i>	$RC_h = RC_0(1 - h / h_{abs})$
<i>page 152, Eqn. (3.38)</i>	$\sin\gamma = \frac{T}{W} \left[P_{dl} - \sqrt{P_{dl}^2 - P_{dl} + \left(1 + \left(\frac{L}{D} \right)^2 \right)^{-1} \left(\frac{T}{W} \right)^{-2}} \right]$

page 186, Section 3.7.4.2

line 3 ...groundrun as $< 2,400$ ft.

line 7 $S_L = 1.9 \times 2,400 =$
 $= 4,500$ ft.

From Figure 3.16 $S_L = 4,500/0.6 = 7,500$ ft.

From Figure 3.17 this yields: $V_A^2 = 25,000$ kts².

$$V_A = \{21,200(1.3/1.2)^2\}^{1/2} = 158 \text{ kts} \text{ should be}$$

$$V_A = \{25,000\}^{1/2} = 158 \text{ kts}$$

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page 102, Step 3.1, 2nd line ...falls into one of the eight catagories...

page 158, Step 6.10 Eqn. (6.1) should be Eqn. (6.2)

page 170,
Eqn (7.8) and (7.11-18) C_l should be c_l

pages 176 to 185 The example problems of Section 7.2 are incorrect. The K_A factor was multiplied instead of divided to yield the $C_{l_{max}}$ values for Step 7.4 of 7.2.1, 7.2.2, and 7.2.3. Each example will be addressed below.

Section 7.2.1 Twin Engine Propeller Driven Airplane

The results of step 7.4 should be:

	Take-off flaps		Landing flaps	
$\frac{S_{wf}}{S}$	0.3	0.6	0.3	0.6
$\Delta C_{l_{max}}$	0.58	0.29	2.32	1.16

Z_{th} should be $\frac{Z_{fh}}{c}$.

For Step 7.5, the referenced equations and figures are wrong:

Eqn. (7.15) should be Eqn. (7.16).

Eqn. (7.14) should be Eqn. (7.15).

Eqn. (7.13) should be Eqn. (7.14).

Figure 7.7 should be Figure 7.8.

Figure 7.3b should be Figure 7.4.

Eqn. (7.10) should be Eqn. (7.11).

Section 7.2.2 Jet Transport

The results of step 7.4 should be:

	Take-off flaps		Landing flaps	
$\frac{S_{wf}}{S}$	0.6	0.8	0.6	0.8
$\Delta C_{l_{max}}$	3.00	2.24	3.84	2.88

For Step 7.5, the referenced equations and figures are wrong:

Eqn. (7.10) should be Eqn. (7.11)

Figure 7.3b should be Figure 7.4

Section 7.2.3 Fighter

The results of Step 7.4 should be:

	Take-off flaps		
$\frac{S_{wf}}{S}$	0.4	0.8	1.0
$\Delta C_{l_{max}}$	4.00	2.000	1.60

These corrections will affect the results of each sample problem. It is left to the reader to complete the sample problems using the correct results of Step 7.4. The summary and referenced drawings of Step 7.6 may change due to these corrections.

pages 178, 181, and 184

Under Step 7.4, K_{Δ} should be K_{Λ}

page 267

Eqn (11.13)

$N_D = 0.75 N_{t_{crit}}$ should be $N_D = 0.25 N_{t_{crit}}$

Eqn (11.14)

$N_D = 0.25 N_{t_{crit}}$ should be $N_D = 0.10 N_{t_{crit}}$

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ERRATA: AIRPLANE DESIGN PART III

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page 15, Table 2.3 Switch values for β_1 and β_2

page 194, 8th line from top replace “stability” with “Stability”.

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ERRATA: AIRPLANE DESIGN PART IV

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page 54, Table 2.18 For fighters and trainers, the details are in Figure 2.26, not Figure 2.25.

page 380, 7th line from top replace “is” with “are”

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ERRATA: AIRPLANE DESIGN PART V

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- page 34, Eqn (4.13)* $n_{lim_{pos}} \geq 2.1 + 24,000 / (GW + 10,000)$
- page 43, 12th line from top* V_A should be 217 kts.
- page 45, 8th line* Change *Selene* to *Eris*
- page 61, under Step 6* $n_{ult} = 7.33$ should read $n_{lim} = 7.33$
- page 71*
Eqn (5.12) 57.5 should be 174.04
- Eqn (5.13)* 15.6 should be 639.95
Replace exponent 1.249 with 0.1249
- page 72*
6th line replace 'ib' with 'in'
- 13th line* replace $1/4_V$ by $\Lambda_{1/4_V}$
- page 72 - 74* All comments about the canard weight should reference 5.2.1.1.
- page 74*
Eqn (5.19) Replace $1/2_H$ by $\Lambda_{1/2_H}$
- Eqn (5.20)*
$$W_v = K_v S_v \left[3.81 (S_v^{0.2} V_D) / \left(1000 \sqrt{\cos \Lambda_{c/2_v}} \right) - 0.287 \right]$$

Replace $1/2_V$ by $\Lambda_{1/2_V}$
- page 75, Eqn (5.23)*
$$W_f = 0.04682 (W_{TO})^{0.692} (P_{max})^{0.374} (l_{f-n})^{0.590}$$

where P_{max} is the maximum fuselage perimeter expressed in feet.
- page 76*
Eqn (5.24) N_{pax} is the number of passengers including the pilot.
- Eqn (5.26)* Replace 2×10.43 by 10.43
- page 77, Eqn (5.27)* l_h = distance from wing root c/4 to horizontal tail root c/4 in ft
- page 78, Eqn (5.29)* $W_n = K_n W_{TO}$ should be $W_n = K_n P_{TO}$

page 79
2nd line

Eliminate and replace by “P_{TO} = Take-off power in HP”

Eqn (5.32)

$$W_n = 0.045(P_{TO})^{5/4} (N_e)^{-1/4}$$

page 81

Eqn (5.38)

$$W_g = 0.013W_{TO} + 0.362(W_L)^{0.417} (n_{ult,l})^{0.950} (l_{sm})^{0.183} + 6.2 + \\ + 0.0013W_{TO} + 0.007157(W_L)^{0.749} (n_{ult,l})(l_{sn})^{0.788}$$

7th line from bottom

Replace N_{ult,l} by n_{ult,l}

4th line from bottom

Replace 62.61 by 62.21

page 85

Section 6.1.2, 9th line

Should read: *Equations (6.4) and (6.6) may also be used...*

page 87, Eqn (6.8)

$$W_{ai} + W_p = 1.03(N_e)^{0.3} (P_{TO})^{0.7}$$

page 90, Eqn (6.14)

Method assumes that the number of engines equals the number of propellers

page 92, Eqn (6.23)

$$W_{fs} = 1.6 \left[\frac{W_f}{K_{fsp}} \right]^{0.727}$$

See the associated insert for the comparison of Torenbeek and GD methods.

page 93,

Add an increment of 5 to all equation numbers throughout Chapter 6 (i.e., Eqn. (6.22) becomes Eqn. (6.27)).

page 95, Eqn (6.34b)

$$W_{apsi} = 0.4K_b (N_e)^{0.2} (P_{TO})^{0.8}$$

page 98,

Add an increment of 1 to all equation numbers throughout Chapter 7.

page 99, Eqn (7.4)

$$W_{fc} = 0.33(W_{TO})^{2/3}$$

page 108,

Eqn (7.44) Remove the (before N_{pax} in the cabin windows weight component.

page 109, Eqn (7.46)

$$K_{st} = 0 \text{ for no ejection seat}$$

page 111,
3rd line of Section 7.12

Should read: *Part IV, Chapter 3.*

ERRATA: AIRPLANE DESIGN PART VI

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page xx

$$\bar{x}_{ac_h} = x_{ac_h} / \bar{c}$$

page 27, Eqn (4.9)

$$C_{L_w} = C_L - C_{L_c} \frac{S_c}{S} - C_{L_h} \frac{S_h}{S}$$

page 46, Eqn (4.33)

$$C_{D_{L_{fus}}} = 2\alpha^2 \frac{S_{b_{fus}}}{S} + \eta c_{d_c} |\alpha|^3 \frac{S_{plf_{fus}}}{S}$$

page 47, Figure 4.20

$$M_c = M \sin |\alpha|$$

page 49

Eqn (4.39)

$$C_{D_{L_{fus}}} = \alpha^2 (S_{b_{fus}}) / S$$

Eqn. (4.41)

$$C_{D_{o_{fus}}} = \left(C_{f_{fus}} \left(\frac{S_{wet_{fus}}}{S_{fus}} \right) + C_{D_{N_2}} + C_{D_A} + C_{D_{A(NC)}} + C_{D_{b_{fus}}} \right) \frac{S_{fus}}{S}$$

page 52, Eqn (4.43)

$$C_{D_{L_{fus}}} = F \left\{ 2\alpha^2 \frac{S_{b_{fus}}}{S} + c_{d_c} \frac{S_{plf_{fus}}}{S} |\alpha|^3 \right\}$$

page 70, 9th line

Should read “... of 4.2.2.1 but with the appropriate...”

page 73

Eqn. (4.60)

Add: $\epsilon_n > 0$ for upwash and $\epsilon_n < 0$ for downwash

Last line

Should read: Chapter 8.

page 77, Eqn. (4.63)

$\Delta c_{l_2} = +0.056(i_n)$ with i_n expressed in degrees

page 86

3rd line

Should read: ... from Eqn. (4.6)

Eqn. (4.74)

‘Chapter 9’ should be ‘Chapter 8’

page 105, Eqn (4.84)

$$\begin{aligned} \Delta C_{D_{trim_{prof}}} = & \left(\Delta C_{D_p} \right)_{\Lambda_{c/4_h}=0} \cos \Lambda_{c/4_h} \left(\frac{S_{ef}}{S_h} \right) \left(\frac{S_h}{S} \right) \\ & + \left(\Delta C_{D_p} \right)_{\Lambda_{c/4_c}=0} \cos \Lambda_{c/4_c} \left(\frac{S_{cf}}{S_c} \right) \left(\frac{S_c}{S} \right) \end{aligned}$$

page 142

The reference to Chapter 6 in Part IV should be Chapter 7

page 171, Eqn. (6.25)

Replace \dot{m}_{gas} with \dot{m}_a

Where \dot{m}_a follows from Eqn. (6.19)

page 177, 22nd line

Section on supersonic jet inlets should be Section 6.2.3.4

page 181, Eqn. (6.44)

$$F_{inl} = 1 + 1.75 \left\{ \left(\frac{\mu_{inl} - 1}{\mu_{inl}} \right) \left(\frac{1}{\frac{A_m}{A_c} - 1} \right) \right\}$$

page 229, Eqn. (8.7)

$$\Delta c_l = \eta_1 \left(c_{l_{\delta f_1}} \right) \left(\delta_{f_1} \right) \left\{ (c + c_1) / c \right\} + \eta_2 \left(c_{l_{\delta f_2}} \right) \left(\delta_{f_2} \right) (c' / c)$$

page 233, Eqn. (8.10)

$$\Phi_{TEUPPER} = \arctan \left\{ 10 \frac{y_{90} - y_{100}}{c} \right\}$$

page 245, Eqn. (8.20)

$$\alpha_w = \alpha + i_w$$

page 268, Eqn. (8.32)

Should be

$$C_{L_o} = C_{L_{owf}} + C_{L_{\alpha_h}} \eta_h (S_h / S) \left(-\varepsilon_{oh} - \alpha_{oL_h} \right) \\ + C_{L_{\alpha_c}} \eta_c (S_c / S) \left(\varepsilon_{oc} - \alpha_{oL_c} \right)$$

where: α_{oL_h} and α_{oL_c} can be found using the method of Section 8.1.3.1.

page 269, Eqn (8.37)

For jet airplanes, the horizontal tail dynamic pressure should be calculated from:

$$\eta_h = 1 - \frac{2.42 \sqrt{C_{D_{ow}}} \cos^2 \left(\frac{\pi z_{h_{wake}}}{2 \Delta z_{wake}} \right)}{\frac{x_{h_{wake}}}{\bar{c}} + 0.30}$$

where:

$C_{D_{ow}}$ is the wing zero-lift drag coefficient as found from 4.2.1.1.

$$z_{h_{wake}} = a \sin(\gamma_h - \alpha - i_w + \varepsilon_h)$$

$$x_{h_{wake}} = a \cos(\gamma_h - \alpha - i_w + \varepsilon_h)$$

$$\Delta z_{wake} = 0.68 \bar{c} \sqrt{C_{D_{ow}} \left(\frac{x_{h_{wake}}}{\bar{c}} + 0.15 \right)}$$

page 323, 1 st line	Should read <i>airplane zero angle of attack. . .</i>
page 333, Eqn. (8.97)	$\varepsilon = \varepsilon_{o_h} + \alpha \left(\frac{d\varepsilon_h}{d\alpha} \right)$
page 333, Eqn. (8.97)	$\varepsilon = \varepsilon_{o_c} + \alpha \left(\frac{d\varepsilon_c}{d\alpha} \right)$
page 340, Eqn. (8.107)	$K_{T_i} = \frac{550 \text{ SHP}_{AV_i} \sqrt{\rho}}{(2W/S)^{3/2} D_{P_i}^2}$
page 342, Eqn. (8.108)	$(dC_m/dC_L)_N = \sum_{i=1}^n \left[\frac{(dC_N/d\alpha)_{P_i} (d\bar{\varepsilon}_{P_i}/d\alpha) (l_{P_i}) (0.79) (D_{P_i})^2}{S \bar{c} C_{L\alpha_w}} \right]$
page 374, Eqn. (10.8)	$C_{T_{X_1}} = C_{D_1}$
page 375, Last Line	$\partial C_D / \partial C_m$ should be $\partial C_D / \partial M$.
page 377 Eqn. (10.12)	$C_{m_u} = -C_L \left(\partial \bar{X}_{aca} / \partial M \right) M$
Eqn. (10.13)	$C_{T_{x_u}} = (1/\bar{q}S) (\partial P_{reqd} / \partial u) - 3C_{T_{x_1}}$
Eqn. (10.15)	$C_{T_{X_u}} = (M_1 / \bar{q}S) (\partial T_{reqd} / \partial M) - 3C_{T_{X_1}}$
page 382, Eqn (10.24)	Add a ‘)’ to the end of Equation 10.24
2 nd line below Eqn (10.24)	Equation ‘(10.23)’ should be equation ‘(10.22)’.
page 390, Fig. (10.16)	z_h should be ‘the vertical distance between the horizontal tail aerodynamic center to the fuselage center line’.
page 397, 6 th line from bottom	Replace $C_{y\beta}$ by $C_{y\beta_v}$
page 398, Eqn (10.44)	$C_{n_{T\beta}} = - \sum_{i=1}^n \left[\left\{ (dC_N/d\alpha)_{P_i} (0.79) (D_{P_i})^2 (l_{P_i}) \right\} / Sb \right]$
page 401~415, Fig.30~33	$z_v = z_p \cos \alpha_f - l_p \cos \alpha_f$

page 417, Eqn (10.50)

$$C_{y_p} = 2C_{y_{\beta_v}} \left(\frac{z_v \cos \alpha - l_v \sin \alpha - z_v}{b} \right) + 3 \sin \Gamma \left(1 - \frac{4z_v}{b} \sin \Gamma \right) \left(C_{l_p} \right)_{\substack{\Gamma=0 \\ C_L=0}}$$

where: z - is the vertical distance between the cg and the wing root quarter-chord point.

$$\left(C_{l_p} \right)_{\substack{\Gamma=0 \\ C_L=0}} = \frac{k}{\beta} \left(\frac{\beta C_{l_p}}{k} \right)_{C_L=0}$$

page 418, Figure 10.35

Replace $\frac{\beta C_{l_p}}{k}$ with $\left(\frac{\beta C_{l_p}}{k} \right)_{C_L=0}$

page 419, Eqn. (10.55)

$$\frac{\left(C_{l_p} \right)_{\Gamma}}{\left(C_{l_p} \right)_{\Gamma=0}} = 1 - \frac{4z_w}{b} \sin \Gamma + 12 \left(\frac{z_w}{b} \sin \Gamma \right)^2$$

page 421, Eqn.(10.62)

$$C_{n_{p_w}} = \left\{ \left(C_{n_p} / C_L \right)_{C_L=0} \right\} C_{L_w} + \left(C_{n_p} / \varepsilon_t \right) \varepsilon_t + \left[\Delta C_{n_p} / \left(\alpha_{\delta_f} \delta_f \right) \right] \alpha_{\delta_f} \delta_f$$

page 422, Eqn. (10.66)

$$\alpha_{\delta_f} = \Delta c_l / \left(c_{l_{\alpha}} \delta_f \right)$$

page 424, Eqn. (10.71)

$$\left(C_{L_{q_w}} \right)_{M=0} = \left(0.5 + 2 \frac{x_w}{\bar{c}} \right) C_{L_{\alpha_w}}$$

page 435, Eqn. (10.89)

$$C_{D_{i_h}} = \frac{2C_L}{\pi A e} C_{L_{\alpha_h}} \eta_h \frac{S_h}{S}$$

page 439,

Eqn. (10.97)

$$C_{D_{i_c}} = \frac{2C_L}{\pi A e} C_{L_{\alpha_c}} \eta_c \frac{S_c}{S}$$

Eqn. (10.100)

$$C_{m_{i_c}} = C_{L_{\alpha_c}} \eta_c \bar{V}_c$$

page 440, Eqn (10.102)

Replace $c_{l_{\alpha_h}}$ with $c_{l_{\alpha_c}}$

page 446, Eqn (10.110)

$$c_{l_{\delta}} = \frac{c_{l_{\delta}}}{\left(c_{l_{\delta}} \right)_{theory}} \left(c_{l_{\delta}} \right)_{theory} k'$$

where k' is found from Figure 8.13

page 447,

Eqns. (10.111) & (10.113) It is assumed that: $\left(C_{l\delta}\right)_{left} = \left(C_{l\delta}\right)_{right}$

page 461, Eqn. (10.123) Should read:

$$C_{y\delta_r} = K_{\delta} C_{L\alpha_v} \frac{S_v}{S} \left\{ \frac{c_{l\delta}}{\left(c_{l\delta}\right)_{theory}} \right\} \left(c_{l\delta}\right)_{theory} \left(\frac{k'}{c_{l\alpha_v}} \right) \left\{ \frac{(\alpha_{\delta})_{CL}}{(\alpha_{\delta})_{cl}} \right\}$$

Eqn (10.123) is correct for a single vertical tail only. For a twin vertical tail:

$$C_{y\delta_r} = 2 \left(\frac{C_{y\beta_{v(wfh)}}}{C_{y\beta_{veff}}} \right) K_b C_{L\alpha_v} \frac{S_v}{S} \left\{ \frac{c_{l\delta}}{\left(c_{l\delta}\right)_{theory}} \right\} \left(c_{l\delta}\right)_{theory} \left(\frac{k'}{c_{l\alpha_v}} \right) \left\{ \frac{(\alpha_{\delta})_{CL}}{(\alpha_{\delta})_{cl}} \right\}$$

where: $\left(\frac{C_{y\beta_{v(wfh)}}}{C_{y\beta_{veff}}} \right)$ is found from Figure 10.17.

All other parameters are the same.

page 467, Eqn. (10.129) $\left(c_{h\alpha}\right)_{theory}$ is found from Figure 10.63b. The parameter $\frac{c_{l\alpha}}{\left(c_{l\alpha}\right)_{theory}}$ in Figure 10.63b is itself found from Figure 10.64a with the assumption that $\tan \frac{\Phi'_{TE}}{2} = \frac{t}{c}$.

page 470,
1st line

(10.126) should be (10.128).

Eqn. (10.130)

$\frac{c_{l\alpha}}{\left(c_{l\alpha}\right)_{theory}}$ is obtained from Figure 10.64a with the assumption that $\tan \frac{\Phi'_{TE}}{2} = \frac{t}{c}$.

page 484, Eqn (10.145)

Replace ' α_{δ} ' with ' $-\alpha_{\delta}$ '.

page 521,

(Pratt and Whitney handbook errors)

Pressure (psia) for 200,000 ft should be 0.002655 psia

Pressure (psia) for 200,131 ft should be 0.002641 psia

Pressure Ratio, δ , for 154,199 ft should be 0.001095

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- page 11,*
last sentence of 3rd para. Typical numerical values for gearing ratios are given in Table 4.1 of Part IV, not Part VI.
- page 39, Figure 2.5* z_T should be negative as shown
- page 44, Eqn. (2.39)* Should read:
- $$S_h = \frac{-z_T T + z_D D + W(x_{mg} - x_{cg} + \mu_g z_{mg}) - L_{wf}(x_{mg} - x_{ac_{wf}} + \mu_g z_{mg}) - C_{mac_{wf_g}} \bar{q}_{rot} S \bar{c} + I_{yy_{mg}} \ddot{\Theta}}{\bar{q}_{rot}(x_{mg} - x_{ac_h} + \mu_g z_{mg}) C_{L_{h_{max}}}}$$
- page 49, Eqn. (2.54)* The 4th term on the left hand side should read:
'+ $Y_{ng}(x_{ng} + x_{cg}) - \dots$ '
- page 50, Eqn. (2.57)* The 4th term on the left hand side should read:
 $0.025(\Psi_A + \Psi_{steer}) P_{ng}(x_{ng} + x_{cg})$
- page 98, 1st sentence* Should read, "Civil: FAR 23.201, 23.203, 23.205, ..."
- page 152, Eqn. (5.59)* $T \sin(\alpha + \phi_t) + C_L \bar{q} S - W \cos \phi - (W/g) U_1 Q_1 \sin \phi = 0$
- page 159,*
Last sentence of 1st para. Should read, "See Section 5.3."
- page 161, Eqn. (5.77)* $RD = \left\{ (W/S)(2/\rho)(C_D^2/C_L^3)(\cos \gamma)^3 \right\}^{1/2}$
- page 164, AS-5263* thrust required for level flight at $1.15V_s$, not $1.15V_{s_{PA}}$.