Table B1.5 Longitudinal Dimensional Stability Derivatives for the Cessna 182 Aircraft

Cruise
$X_u = -0.0304,\ X_{T_u} = -0.0152,\ X_\alpha = 19.459,\ X_{\delta_E} = 0$
$Z_u = -0.2919,\ Z_\alpha = -464.71,\ Z_{\dot{\alpha}} = -1.98,\ Z_q = -4.542,\ Z_{\delta_E} = -44.985$
$M_u = 0,\ M_{T_u} = 0,\ M_\alpha = -19.26,\ M_{T_\alpha} = 0,\ M_{\dot{\alpha}} = -2.543,\ M_q = -4.337,\ M_{\delta_E} = -35.251$

Table B1.6 Longitudinal Transfer Functions for the Cessna 182 Aircraft

Cruise

$$\frac{\alpha(s)}{\delta_E(s)} = \frac{Num_\alpha(s)}{\overline{D}_1(s)} = \frac{A_\alpha s^3 + B_\alpha s^2 + C_\alpha s + D_\alpha}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-44.985\, s^3 - 7794.87\, s^2 - 355.63\, s - 330.516}{222.05\, s^4 + 1985.95\, s^3 + 6262.28\, s^2 + 329.88\, s + 180.58}$$

$$\frac{u(s)}{\delta_E(s)} = \frac{Num_u(s)}{\overline{D}_1(s)} = \frac{A_u s^2 + B_u s + C_u}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-875.36\, s^2 + 96137.81\, s + 498397.28}{222.05\, s^4 + 1985.95\, s^3 + 6262.28\, s^2 + 329.88\, s + 180.58}$$

$$\frac{\theta(s)}{\delta_E(s)} = \frac{Num_\theta(s)}{\overline{D}_1(s)} = \frac{A_\theta s^2 + B_\theta s + C_\theta}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-7713.23\, s^2 - 15867.0\, s - 908.24}{222.05\, s^4 + 1985.95\, s^3 + 6262.28\, s^2 + 329.88\, s + 180.58}$$

$$roots\left(\overline{D}_1(s)\right) = -4.45 \pm i\,2.825, \quad -0.022 \pm i\,0.17$$

$$\zeta_{SP} = 0.844, \quad \omega_{nSP} = 5.27, \quad \zeta_{Ph} = 0.129, \quad \omega_{nPh} = 0.171$$

Table B1.7 Lateral Directional Aerodynamic Coefficients for the Cessna 182 Aircraft

	Climb	Cruise	Approach
Stability Derivatives			
c_{l_β}	−0.0895	−0.0923	−0.969
c_{l_p}	−0.487	−0.484	−0.494
c_{l_r}	0.1869	0.0798	0.2039
c_{Y_β}	−0.404	−0.393	−0.303
c_{Y_p}	−0.145	−0.075	−0.213
c_{Y_r}	0.267	0.214	0.201
c_{n_β}	0.0907	0.0587	0.0701
$c_{n_{T_\beta}}$	0	0	0
c_{n_p}	−0.0649	−0.0278	−0.096
c_{n_r}	−0.1199	−0.0937	−0.1151
Control Derivatives			
$c_{l_{\delta_A}}$	0.229	0.229	0.229
$c_{l_{\delta_R}}$	0.0147	0.0147	0.0147
$c_{Y_{\delta_A}}$	0	0	0
$c_{Y_{\delta_R}}$	0.187	0.187	0.187
$c_{n_{\delta_A}}$	−0.0504	−0.0216	−0.0786
$c_{n_{\delta_R}}$	−0.0805	−0.0645	−0.0604

Table B2.5 Longitudinal Dimensional Stability Derivatives for the Cessna 310 Aircraft

Climb
$X_u = -0.0281,\ X_{T_u} = -0.0141,\ X_\alpha = 15.284,\ X_{\delta_E} = 0$
$Z_u = -0.3593,\ Z_\alpha = -215.94,\ Z_{\dot\alpha} = -2.806,\ Z_q = -5.487,\ Z_{\delta_E} = -41.94$
$M_u = 0,\ M_{T_u} = 0,\ M_\alpha = -5.58,\ M_{T\alpha} = 0,\ M_{\dot\alpha} = -3.259,\ M_q = -6.431,\ M_{\delta_E} = -41.64$

Table B2.6 Longitudinal Transfer Functions for the Cessna 310 Aircraft

Climb

$$\frac{\alpha(s)}{\delta_E(s)} = \frac{Num_\alpha(s)}{\overline{D}_1(s)} = \frac{A_\alpha s^3 + B_\alpha s^2 + C_\alpha s + D_\alpha}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-41.939\, s^3 - 7495.56\, s^2 - 199.31\, s - 474.58}{181.79\, s^4 + 1958.13\, s^3 + 2435.24\, s^2 + 156.22\, s + 63.59}$$

$$\frac{u(s)}{\delta_E(s)} = \frac{Num_u(s)}{\overline{D}_1(s)} = \frac{A_u s^2 + B_u s + C_u}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-641.0\, s^2 + 123693.04\, s + 282474.70}{181.79\, s^4 + 1958.13\, s^3 + 2435.24\, s^2 + 156.22\, s + 63.59}$$

$$\frac{\theta(s)}{\delta_E(s)} = \frac{Num_\theta(s)}{\overline{D}_1(s)} = \frac{A_\theta s^2 + B_\theta s + C_\theta}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-7432.72\, s^2 - 9070.95\, s - 598.03}{181.79\, s^4 + 1958.13\, s^3 + 2435.24\, s^2 + 156.22\, s + 63.59}$$

$$roots\left(\overline{D}_1(s)\right) = -9.3477,\quad -1.3796,\quad -0.022 \pm i\,0.1632$$

$$(Degenerated\ Short\ Period)\, T_{SP-1} = 0.107,\ T_{SP-2} = 0.725,\quad \zeta_{Ph} = 0.1338,\quad \omega_{nPh} = 0.165$$

Table B2.7 Lateral Directional Aerodynamic Coefficients for the Cessna 310 Aircraft

	Climb	Cruise	Approach
Stability Derivatives			
c_{l_β}	−0.0923	−0.1096	−0.0965
c_{l_p}	−0.552	−0.551	−0.566
c_{l_r}	0.1746	0.0729	0.2433
c_{Y_β}	−0.610	−0.698	−0.577
c_{Y_p}	−0.2093	−0.1410	−0.2897
c_{Y_r}	0.356	0.355	0.355
c_{n_β}	0.1552	0.1444	0.1683
$c_{n_{T_\beta}}$	0	0	0
c_{n_p}	−0.0615	−0.0257	−0.1021
c_{n_r}	−0.1561	−0.1495	−0.1947
Control Derivatives			
$c_{l_{\delta_A}}$	0.172	0.172	0.172
$c_{l_{\delta_R}}$	0.0192	0.0192	0.0192
$c_{Y_{\delta_A}}$	0	0	0
$c_{Y_{\delta_R}}$	0.230	0.230	0.230
$c_{n_{\delta_A}}$	−0.0402	−0.0168	−0.0676
$c_{n_{\delta_R}}$	−0.1152	−0.1152	−0.1152

Table B3.5 Longitudinal Dimensional Stability Derivatives for the Beech 99 Aircraft

Cruise
$X_u = -0.0138,\ X_{T_u} = 0.0,\ X_\alpha = 18.27,\ X_{\delta_E} = 0$
$Z_u = -0.147,\ Z_\alpha = -575.23,\ Z_{\dot\alpha} = -1.885,\ Z_q = -6.108,\ Z_{\delta_E} = -62.64$
$M_u = 0,\ M_{T_u} = 0,\ M_\alpha = -21.79,\ M_{T_\alpha} = 0,\ M_{\dot\alpha} = -0.758,\ M_q = -2.8314,\ M_{\delta_E} = -23.06$

Table B3.6 Longitudinal Transfer Functions for the Beech 99 Aircraft

Cruise

$$\frac{\alpha(s)}{\delta_E(s)} = \frac{Num_\alpha(s)}{\overline{D}_1(s)} = \frac{A_\alpha s^3 + B_\alpha s^2 + C_\alpha s + D_\alpha}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-62.641\, s^3 - 10{,}412.59\, s^2 - 129.83\, s - 107.898}{451.835\, s^4 + 2{,}197.16\, s^3 + 11{,}332.70\, s^2 + 154.027\, s + 101.963}$$

$$\frac{u(s)}{\delta_E(s)} = \frac{Num_u(s)}{\overline{D}_1(s)} = \frac{A_u s^2 + B_u s + C_u}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-1{,}144.47\, s^2 + 141{,}313.74\, s + 380{,}639.61}{451.835\, s^4 + 2{,}197.16\, s^3 + 11{,}332.70\, s^2 + 154.027\, s + 101.963}$$

$$\frac{\theta(s)}{\delta_E(s)} = \frac{Num_\theta(s)}{\overline{D}_1(s)} = \frac{A_\theta s^2 + B_\theta s + C_\theta}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-10{,}371.21\, s^2 - 12{,}042.51\, s - 226.33}{451.835\, s^4 + 2{,}197.16\, s^3 + 11{,}332.70\, s^2 + 154.027\, s + 101.963}$$

$$roots\left(\overline{D}_1(s)\right) = -2.4254 \pm i\,4.374, \quad -0.0059 \pm i\,0.0948$$
$$\zeta_{SP} = 0.485, \quad \omega_{nSP} = 5.001, \quad \zeta_{Ph} = 0.050, \quad \omega_{nPh} = 0.0625$$

Table B3.7 Lateral Directional Aerodynamic Coefficients for the Beech 99 Aircraft

	Approach	Cruise (low)	Cruise (high)
Stability Derivatives			
c_{l_β}	−0.13	−0.13	−0.13
c_{l_p}	−0.50	−0.50	−0.50
c_{l_r}	0.06	0.14	0.14
c_{Y_β}	−0.59	−0.59	−0.59
c_{Y_p}	−0.21	−0.19	−0.19
c_{Y_r}	0.39	0.39	0.39
c_{n_β}	0.120	0.080	0.080
$c_{n_{T_\beta}}$	0	0	0
c_{n_p}	−0.005	0.019	0.019
c_{n_r}	−0.204	−0.197	−0.197
Control Derivatives			
$c_{l_{\delta_A}}$	0.156	0.156	0.156
$c_{l_{\delta_R}}$	0.0087	0.0109	0.01016
$c_{Y_{\delta_A}}$	0	0	0
$c_{Y_{\delta_R}}$	0.144	0.148	0.144
$c_{n_{\delta_A}}$	−0.0012	−0.0012	−0.0012
$c_{n_{\delta_R}}$	−0.0763	−0.0772	−0.0758

Table B4.5 Longitudinal Dimensional Stability Derivatives for the Cessna T37-A Aircraft

Cruise
$X_u = -0.0111,\ X_{T_u} = -0.0019,\ X_\alpha = 10.809,\ X_{\delta_E} = 0$
$Z_u = -0.14,\ Z_\alpha = -437.415,\ Z_{\dot\alpha} = -1.013,\ Z_q = -2.077,\ Z_{\delta_E} = -42.222$
$M_u = 0,\ M_{T_u} = 0,\ M_\alpha = -19.398,\ M_{T\alpha} = 0,\ M_{\dot\alpha} = -1.1553,\ M_q = -2.477,\ M_{\delta_E} = -31.037$

Table B4.6 Longitudinal Transfer Functions for the Cessna T37-A Aircraft

Cruise

$$\frac{\alpha(s)}{\delta_E(s)} = \frac{Num_\alpha(s)}{\overline{D}_1(s)} = \frac{A_\alpha s^3 + B_\alpha s^2 + C_\alpha s + D_\alpha}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-42.22\, s^3 - 14{,}191.75\, s^2 - 149.454\, s - 137.98}{456.96\, s^4 + 2{,}099.46\, s^3 + 9{,}914.89\, s^2 + 115.49\, s + 86.235}$$

$$\frac{u(s)}{\delta_E(s)} = \frac{Num_u(s)}{\overline{D}_1(s)} = \frac{A_u s^2 + B_u s + C_u}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-456.36\, s^2 + 296{,}829.82\, s + 406{,}732.25}{456.96\, s^4 + 2{,}099.46\, s^3 + 9{,}914.89\, s^2 + 115.49\, s + 86.235}$$

$$\frac{\theta(s)}{\delta_E(s)} = \frac{Num_\theta(s)}{\overline{D}_1(s)} = \frac{A_\theta s^2 + B_\theta s + C_\theta}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-7713.23\, s^2 - 15867.0\, s - 908.24}{456.96\, s^4 + 2{,}099.46\, s^3 + 9{,}914.89\, s^2 + 115.49\, s + 86.235}$$

$$roots\left(\overline{D}_1(s)\right) = -2.2923 \pm i\, 4.0483, \quad -0.0049 \pm i\, 0.0932$$
$$\zeta_{SP} = 0.493, \quad \omega_{nSP} = 4.6523, \quad \zeta_{Ph} = 0.0526, \quad \omega_{nPh} = 0.0934$$

Table B4.7 Lateral Directional Aerodynamic Coefficients for the Cessna T37-A Aircraft

	Climb	Cruise	Approach
Stability Derivatives			
c_{l_β}	−0.0851	−0.0944	−0.0822
c_{l_p}	−0.440	−0.442	−0.458
c_{l_r}	0.0590	0.0926	0.2540
c_{Y_β}	−0.361	−0.346	−0.303
c_{Y_p}	−0.0635	−0.0827	−0.1908
c_{Y_r}	0.314	0.300	0.263
c_{n_β}	0.1052	0.1106	0.1095
$c_{n_{T_\beta}}$	0	0	0
c_{n_p}	−0.0154	−0.0243	−0.0768
c_{n_r}	−0.1433	−0.1390	−0.1613
Control Derivatives			
$c_{l_{\delta_A}}$	0.1788	0.1810	0.1788
$c_{l_{\delta_R}}$	0.015	0.015	0.015
$c_{Y_{\delta_A}}$	0	0	0
$c_{Y_{\delta_R}}$	0.2	0.2	0.2
$c_{n_{\delta_A}}$	−0.0160	−0.0254	−0.0760
$c_{n_{\delta_R}}$	−0.0365	−0.0365	−0.0365

Table B5.5 Longitudinal Dimensional Stability Derivatives for the Cessna 620 Aircraft

Approach

$$X_u = -0.0374,\ X_{T_u} = -0.0187,\ X_\alpha = 17.463,\ X_{\delta_E} = 0$$

$$Z_u = -0.34,\ Z_\alpha = -170.41,\ Z_{\dot{\alpha}} = 1.456,\ Z_q = -4.1,\ Z_{\delta_E} = -18.3$$

$$M_u = -0.0,\ M_{T_u} = 0.0,\ M_\alpha = -5.5,\ M_{T_\alpha} = 0.0,$$
$$M_{\dot{\alpha}} = -0.83,\ M_q = -2.181,\ M_{\delta_E} = -9.625$$

Table B5.6 Longitudinal Transfer Functions for the Cessna 620 Aircraft

Approach

$$\frac{\alpha(s)}{\delta_E(s)} = \frac{Num_\alpha(s)}{\overline{D}_1(s)} = \frac{A_\alpha s^3 + B_\alpha s^2 + C_\alpha s + D_\alpha}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$
$$= \frac{-18.3\,s^3 - 1{,}822.4\,s^2 - 69.76\,s - 103.02}{190.635\,s^4 + 750.53\,s^3 + 1{,}434.27\,s^2 + 81.27\,s + 58.87}$$

$$\frac{u(s)}{\delta_E(s)} = \frac{Num_u(s)}{\overline{D}_1(s)} = \frac{A_u s^2 + B_u s + C_u}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$
$$= \frac{-319.59\,s^2 + 26{,}420.82\,s + 49{,}830.26}{190.635\,s^4 + 750.53\,s^3 + 1{,}434.27\,s^2 + 81.27\,s + 58.87}$$

$$\frac{\theta(s)}{\delta_E(s)} = \frac{Num_\theta(s)}{\overline{D}_1(s)} = \frac{A_\theta s^2 + B_\theta s + C_\theta}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$
$$= \frac{-1{,}819.74\,s^2 - 1{,}641.68\,s - 143.55}{190.635\,s^4 + 750.53\,s^3 + 1{,}434.27\,s^2 + 81.27\,s + 58.87}$$

$$roots\left(\overline{D}_1(s)\right) = -1.95 \pm i\,1.88,\quad -0.018 \pm i\,0.2$$
$$\zeta_{SP} = 0.72,\quad \omega_{nSP} = 2.71,\quad \zeta_{Ph} = 0.087,\quad \omega_{nSP} = 0.205$$

Table B5.7 Lateral Directional Aerodynamic Coefficients for the Cessna 620 Aircraft

	Climb	Cruise	Approach
Stability Derivatives			
c_{l_β}	−0.1080	−0.1381	−0.1172
c_{l_p}	−0.570	−0.566	−0.576
c_{l_r}	0.2176	0.1166	0.2307
c_{Y_β}	−0.886	−0.883	−0.907
c_{Y_p}	−0.315	−0.227	−0.343
c_{Y_r}	0.448	0.448	0.447
c_{n_β}	0.1848	0.1739	0.1871
$c_{n_{T_\beta}}$	0	0	0
c_{n_p}	−0.0924	−0.0501	−0.1026
c_{n_r}	−0.208	−0.2	−0.224
Control Derivatives			
$c_{l_{\delta_A}}$	0.1776	0.1776	0.1776
$c_{l_{\delta_R}}$	0.02	0.02	0.02
$c_{Y_{\delta_A}}$	0	0	0
$c_{Y_{\delta_R}}$	0.2	0.2	0.2
$c_{n_{\delta_A}}$	−0.0367	−0.0194	−0.0417
$c_{n_{\delta_R}}$	−0.1054	−0.1054	−0.1054

Table B6.5 Longitudinal Dimensional Stability Derivatives for the Learjet 24 Aircraft

Approach
$X_u = -0.0589,\ X_{T\,u} = -0.0101,\ X_\alpha = 11.337,\ X_{\delta_E} = 0$
$Z_u = -0.382,\ Z_\alpha = -103.516,\ Z_{\dot\alpha} = -0.644,\ Z_q = -1.65,\ Z_{\delta_E} = -7.818$
$M_u = -0.0002,\ M_{T_u} = 0.0001,\ M_\alpha = -1.94,\ M_{T\alpha} = 0,$ $M_{\dot\alpha} = -0.3047,\ M_q = -0.817,\ M_{\delta_E} = -2.88$

Table B6.6 Longitudinal Transfer Functions for the Learjet 24 Aircraft

Approach

$$\frac{\alpha(s)}{\delta_E(s)} = \frac{Num_\alpha(s)}{\overline{D}_1(s)} = \frac{A_\alpha s^3 + B_\alpha s^2 + C_\alpha s + D_\alpha}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-7.8184\,s^3 - 492.02\,s^2 - 25.83\,s - 34.69}{170.62\,s^4 + 305.72\,s^3 + 435.07\,s^2 + 29.87\,s + 23.14}$$

$$\frac{u(s)}{\delta_E(s)} = \frac{Num_u(s)}{\overline{D}_1(s)} = \frac{A_u s^2 + B_u s + C_u}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-88.634\,s^2 + 10{,}112.17\,s + 9{,}166.64}{170.62\,s^4 + 305.72\,s^3 + 435.07\,s^2 + 29.87\,s + 23.14}$$

$$\frac{\theta(s)}{\delta_E(s)} = \frac{Num_\theta(s)}{\overline{D}_1(s)} = \frac{A_\theta s^2 + B_\theta s + C_\theta}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-489.33\,s^2 - 316.90\,s - 32.001}{170.62\,s^4 + 305.72\,s^3 + 435.07\,s^2 + 29.87\,s + 23.14}$$

$$roots\left(\overline{D}_1(s)\right) = -0.881 \pm i\,1.29, \quad -0.0158 \pm i\,0.2353$$

$$\zeta_{SP} = 0.564, \quad \omega_{nSP} = 1.562, \quad \zeta_{Ph} = 0.0671, \quad \omega_{nPh} = 0.2358$$

Table B6.7 Lateral directional Aerodynamic Coefficients for the Learjet 24 Aircraft

	Approach	Cruise (Max Weight)	Cruise (Low Weight)
Stability Derivatives			
c_{l_β}	−0.173	−0.110	−0.100
c_{l_p}	−0.390	−0.450	−0.450
c_{l_r}	0.450	0.160	0.140
c_{Y_β}	−0.730	−0.730	−0.730
c_{Y_p}	0	0	0
c_{Y_r}	0.4	0.4	0.4
c_{n_β}	0.15	0.127	0.124
$c_{n_{T_\beta}}$	0	0	0
c_{n_p}	−0.130	−0.008	−0.022
c_{n_r}	−0.260	−0.200	−0.200
Control Derivatives			
$c_{l_{\delta_A}}$	0.149	0.178	0.178
$c_{l_{\delta_R}}$	0.014	0.019	0.021
$c_{Y_{\delta_A}}$	0	0	0
$c_{Y_{\delta_R}}$	0.140	0.140	0.140
$c_{n_{\delta_A}}$	−0.05	−0.02	−0.02
$c_{n_{\delta_R}}$	−0.074	−0.074	−0.074

Table B7.5 Longitudinal Dimensional Stability Derivatives for the Boeing B747-200 Aircraft

Cruise (high)
$X_u = -0.0218,\ X_{T_u} = -0.0604,\ X_\alpha = 1.2227,\ X_{\delta_E} = 0$
$Z_u = -0.0569,\ Z_\alpha = -339.0,\ Z_{\dot\alpha} = -7.666,\ Z_q = -7.474,\ Z_{\delta_E} = -18.341$
$M_u = -0.0001,\ M_{T_u} = 0.0,\ M_\alpha = -1.616,\ M_{T\alpha} = 0,$ $M_{\dot\alpha} = -0.1425,\ M_q = -0.4038,\ M_{\delta_E} = -1.2124$

Table B7.6 Longitudinal Transfer Functions for the Boeing B747-200 Aircraft

Cruise (high)

$$\frac{\alpha(s)}{\delta_E(s)} = \frac{Num_\alpha(s)}{\overline{D}_1(s)} = \frac{A_\alpha s^3 + B_\alpha s^2 + C_\alpha s + D_\alpha}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-18.341\, s^3 - 1{,}055.696\, s^2 - 84.97\, s - 1.995}{878.568\, s^4 + 888.97\, s^3 + 1{,}599.56\, s^2 + 121.194\, s + 1.617}$$

$$\frac{u(s)}{\delta_E(s)} = \frac{Num_u(s)}{\overline{D}_1(s)} = \frac{A_u s^2 + B_u s + C_u}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-22.426\, s^2 + 32{,}442.603\, s + 12{,}108.424}{878.568\, s^4 + 888.97\, s^3 + 1{,}599.56\, s^2 + 121.194\, s + 1.617}$$

$$\frac{\theta(s)}{\delta_E(s)} = \frac{Num_\theta(s)}{\overline{D}_1(s)} = \frac{A_\theta s^2 + B_\theta s + C_\theta}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-1{,}062.524\, s^2 - 468.614\, s - 31.403}{878.568\, s^4 + 888.97\, s^3 + 1{,}599.56\, s^2 + 121.194\, s + 1.617}$$

$$roots\left(\overline{D}_1(s)\right) = -0.4667 \pm i\, 1.2364, \quad -0.0612, \ -0.0172$$

$$\zeta_{SP} = 0.353, \quad \omega_{nSP} = 1.3215, \quad T_1 = 16.34, \ T_2 = 58.05 \ (Degenerated\ \ Phugoid)$$

Table B7.7 Lateral Directional Aerodynamic Coefficients for the Boeing B747−200 Aircraft

	Approach	Cruise (low)	Cruise (high)
Stability Derivatives			
c_{l_β}	−0.281	−0.160	−0.095
c_{l_p}	−0.502	−0.340	−0.320
c_{l_r}	0.195	0.130	0.200
c_{Y_β}	−1.08	−0.90	−0.90
c_{Y_p}	0	0	0
c_{Y_r}	0	0	0
c_{n_β}	0.184	0.160	0.210
$c_{n_{T_\beta}}$	0	0	0
c_{n_p}	−0.222	−0.026	0.02
c_{n_r}	−0.360	−0.280	−0.330
Control Derivatives			
$c_{l_{\delta_A}}$	0.053	0.013	0.014
$c_{l_{\delta_R}}$	0	0.008	0.0005
$c_{Y_{\delta_A}}$	0	0	0
$c_{Y_{\delta_R}}$	0.179	0.120	0.060
$c_{n_{\delta_A}}$	0.0083	0.0018	−0.0028
$c_{n_{\delta_R}}$	−0.113	−0.10	−0.095

Table B8.5 Longitudinal Dimensional Stability Derivatives for the SIAI Marchetti S-211 Aircraft

Approach
$X_u = -0.078,\ X_{T_u} = -0.0055,\ X_\alpha = 6.26,\ X_{\delta_E} = 0$
$Z_u = -0.534,\ Z_\alpha = -119,\ Z_{\dot\alpha} = -1.492,\ Z_q = -4.48,\ Z_{\delta_E} = -8.91$
$M_u = 0.0,\ M_{T_u} = 0.0,\ M_\alpha = -1.75,\ M_{T_\alpha} = 0.0,$ $M_{\dot\alpha} = -0.445,\ M_q = -1.0,\ M_{\delta_E} = -2.625$

Table B8.6 Longitudinal Transfer Functions for the SIAI Marchetti S-211 Aircraft

Approach

$$\frac{\alpha(s)}{\delta_E(s)} = \frac{Num_\alpha(s)}{D_1(s)} = \frac{A_\alpha s^3 + B_\alpha s^2 + C_\alpha s + D_\alpha}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-8.91\, s^3 - 323.34\, s^2 - 14.99\, s - 43.7}{125.48\, s^4 + 307.67\, s^3 + 353.8\, s^2 + 30.1\, s + 29.13}$$

$$\frac{u(s)}{\delta_E(s)} = \frac{Num_u(s)}{D_1(s)} = \frac{A_u s^2 + B_u s + C_u}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-55.75\, s^2 + 8{,}349.51\, s + 9{,}529.46}{125.48\, s^4 + 307.67\, s^3 + 353.8\, s^2 + 30.1\, s + 29.13}$$

$$\frac{\theta(s)}{\delta_E(s)} = \frac{Num_\theta(s)}{D_1(s)} = \frac{A_\theta s^2 + B_\theta s + C_\theta}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-325.43\, s^2 - 323.76\, s - 33.38}{125.48\, s^4 + 307.67\, s^3 + 353.8\, s^2 + 30.1\, s + 29.13}$$

$$roots\,(D_1(s)) = -1.23 \pm i\,1.102, \quad -0.0056 \pm i\,0.293$$

$$\zeta_{SP} = 0.742, \quad \omega_{nSP} = 1.645, \quad \zeta_{Ph} = 0.019, \quad \omega_{nPh} = 0.293$$

Table B8.7 Lateral Directional Aerodynamic Coefficients for the SIAI Marchetti S-211 Aircraft

	Approach	Cruise (low)	Cruise (high)
Stability Derivatives			
c_{l_β}	−0.140	−0.110	−0.110
c_{l_p}	−0.350	−0.390	−0.390
c_{l_r}	0.560	0.280	0.310
c_{Y_β}	−0.94	−1.0	−1.0
c_{Y_p}	−0.010	−0.140	−0.120
c_{Y_r}	0.590	0.610	0.620
c_{n_β}	0.160	0.170	0.170
$c_{n_{T_\beta}}$	0	0	0
c_{n_p}	−0.030	0.090	0.080
c_{n_r}	−0.310	−0.260	−0.260
Control Derivatives			
$c_{l_{\delta_A}}$	0.110	0.10	0.10
$c_{l_{\delta_R}}$	0.030	0.050	0.050
$c_{Y_{\delta_A}}$	0	0	0
$c_{Y_{\delta_R}}$	0.260	0.0280	0.0280
$c_{n_{\delta_A}}$	−0.030	−0.003	−0.005
$c_{n_{\delta_R}}$	−0.110	−0.120	−0.120

Table B9.5 Longitudinal Dimensional Stability Derivatives for the Lockheed F-104 Aircraft

Approach
$X_u = -0.0695,\ X_{T_u} = 0.0035,\ X_\alpha = 14.96,\ X_{\delta_E} = 0$
$Z_u = -0.224,\ Z_\alpha = -140.22,\ Z_{\dot{\alpha}} = -0.418,\ Z_q = -1.456,\ Z_{\delta_E} = -25.9$
$M_u = 0.0,\ M_{T_u} = 0.0,\ M_\alpha = -2.01,\ M_{T_\alpha} = 0.0,$ $M_{\dot{\alpha}} = -0.0856,\ M_q = -0.305,\ M_{\delta_E} = -5$

Table B9.6 Longitudinal Transfer Functions for the Lockheed F-104 Aircraft

Approach

$$\frac{\alpha(s)}{\delta_E(s)} = \frac{Num_\alpha(s)}{\overline{D}_1(s)} = \frac{A_\alpha s^3 + B_\alpha s^2 + C_\alpha s + D_\alpha}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-25.9\,s^3 - 1{,}435.41\,s^2 - 66.68\,s - 33.65}{287.39\,s^4 + 271.25\,s^3 + 636.16\,s^2 + 31.05\,s + 13.55}$$

$$\frac{u(s)}{\delta_E(s)} = \frac{Num_u(s)}{\overline{D}_1(s)} = \frac{A_u s^2 + B_u s + C_u}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-387.34\,s^2 + 23{,}961\,s + 20{,}955.6}{287.39\,s^4 + 271.25\,s^3 + 636.16\,s^2 + 31.05\,s + 13.55}$$

$$\frac{\theta(s)}{\delta_E(s)} = \frac{Num_\theta(s)}{\overline{D}_1(s)} = \frac{A_\theta s^2 + B_\theta s + C_\theta}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-1{,}432.95\,s^2 - 742.73\,s - 59.51}{287.39\,s^4 + 271.25\,s^3 + 636.16\,s^2 + 31.05\,s + 13.55}$$

$$roots\left(\overline{D}_1(s)\right) = -0.45 \pm i\,1.397, \quad -0.02 \pm i\,0.1465$$

$$\zeta_{SP} = 0.307, \quad \omega_{nSP} = 1.468, \quad \zeta_{Ph} = 0.138, \quad \omega_{nPh} = 0.148$$

Table B9.7 Lateral Directional Aerodynamic Coefficients for the Lockheed F-104 Aircraft

	Approach	Cruise
Stability Derivatives		
c_{l_β}	−0.175	−0.093
c_{l_p}	−0.285	−0.272
c_{l_r}	0.265	0.154
c_{Y_β}	−1.180	−1.045
c_{Y_p}	0	0
c_{Y_r}	0	0
c_{n_β}	0.507	0.242
$c_{n_{T_\beta}}$	0	0
c_{n_p}	−0.144	−0.093
c_{n_r}	−0.753	−0.649
Control Derivatives		
$c_{l_{\delta_A}}$	0.0392	0.0173
$c_{l_{\delta_R}}$	0.0448	0.0079
$c_{Y_{\delta_A}}$	0	0
$c_{Y_{\delta_R}}$	0.329	0.087
$c_{n_{\delta_A}}$	0.0042	0.0025
$c_{n_{\delta_R}}$	−0.1645	−0.0435

Table B10.5 Longitudinal Dimensional Stability Derivatives for the McDonnell Douglas F-4 Aircraft

Cruise (mach < 1)
$X_u = -0.0122,\ X_{T_u} = -0.0006,\ X_\alpha = -4.8986,\ X_{i_H} = 12.247$
$Z_u = -0.1105,\ Z_\alpha = -462.92,\ Z_{\dot{\alpha}} = -0.962,\ Z_q = -2.013,\ Z_{i_H} = -48.99$
$M_u = -0.0026,\ M_{T_u} = 0.0,\ M_\alpha = -7.86,\ M_{T_\alpha} = 0,$ $M_{\dot{\alpha}} = -0.233,\ M_q = -0.485,\ M_{i_H} = -11.397$

Table B10.6 Longitudinal Transfer Functions for the McDonnell Douglas F-4 Aircraft

Cruise (mach < 1)

$$\frac{\alpha(s)}{i_H(s)} = \frac{Num_\alpha(s)}{\overline{D}_1(s)} = \frac{A_\alpha s^3 + B_\alpha s^2 + C_\alpha s + D_\alpha}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-48.986\, s^3 - 9{,}985.70\, s^2 - 139.32\, s - 35.68}{876.86\, s^4 + 1{,}102.89\, s^3 + 7{,}106.29\, s^2 - 4.953\, s - 11.154}$$

$$\frac{u(s)}{i_H(s)} = \frac{Num_u(s)}{\overline{D}_1(s)} = \frac{A_u s^2 + B_u s + C_u}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{10{,}738.60\, s^2 + 13{,}610.03\, s + 453{,}126.05}{876.86\, s^4 + 1{,}102.89\, s^3 + 7{,}106.29\, s^2 - 4.953\, s - 11.154}$$

$$\frac{\theta(s)}{i_H(s)} = \frac{Num_\theta(s)}{\overline{D}_1(s)} = \frac{A_\theta s^2 + B_\theta s + C_\theta}{A_1 s^4 + B_1 s^3 + C_1 s^2 + D_1 s + E_1}$$

$$= \frac{-9{,}982.46\, s^2 - 5{,}045.91\, s - 60.94}{876.86\, s^4 + 1{,}102.89\, s^3 + 7{,}106.29\, s^2 - 4.953\, s - 11.154}$$

$roots\left(\overline{D}_1(s)\right) = -0.6291 \pm i\,2.7768, \quad -0.03942,\ 0.0398$

$\zeta_{SP} = 0.221, \quad \omega_{nSP} = 2.847, \quad T_1 = 25.38,\ T_2 = -25.12$ (*Degenerated Unstable Phugoid*)

Table B10.7 Lateral Directional Aerodynamic Coefficients for the McDonnell Douglas F-4 Aircraft

	Approach	Cruise (mach < 1)	Cruise (mach > 1)
Stability Derivatives			
c_{l_β}	−0.156	−0.080	−0.025
c_{l_p}	−0.272	−0.240	−0.20
c_{l_r}	0.205	0.070	0.040
c_{Y_β}	−0.655	−0.680	−0.70
c_{Y_p}	0	0	0
c_{Y_r}	0	0	0
c_{n_β}	0.199	0.125	0.09
$c_{n_{T_\beta}}$	0	0	0
c_{n_p}	0.013	−0.036	0
c_{n_r}	−0.320	−0.270	−0.260
Control Derivatives			
$c_{l_{\delta_A}}$	0.0570	0.0420	0.0150
$c_{l_{\delta_R}}$	0.0009	0.0060	0.0030
$c_{Y_{\delta_A}}$	−0.0355	−0.0160	−0.010
$c_{Y_{\delta_R}}$	0.124	0.095	0.05
$c_{n_{\delta_A}}$	0.0041	−0.0010	−0.0009
$c_{n_{\delta_R}}$	−0.072	−0.066	−0.025