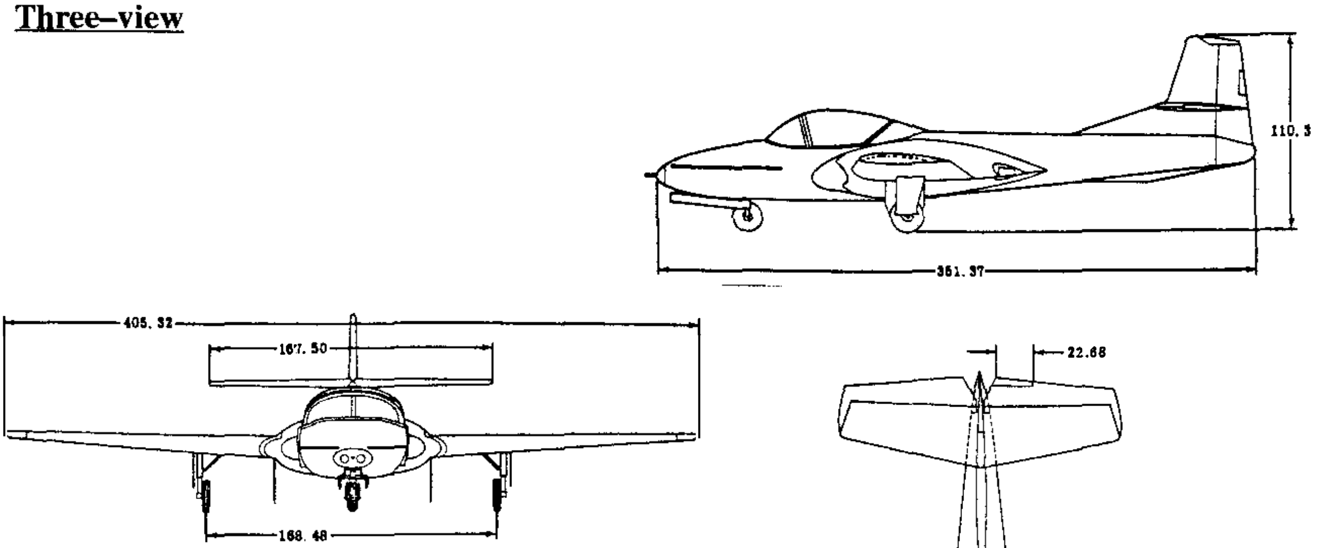
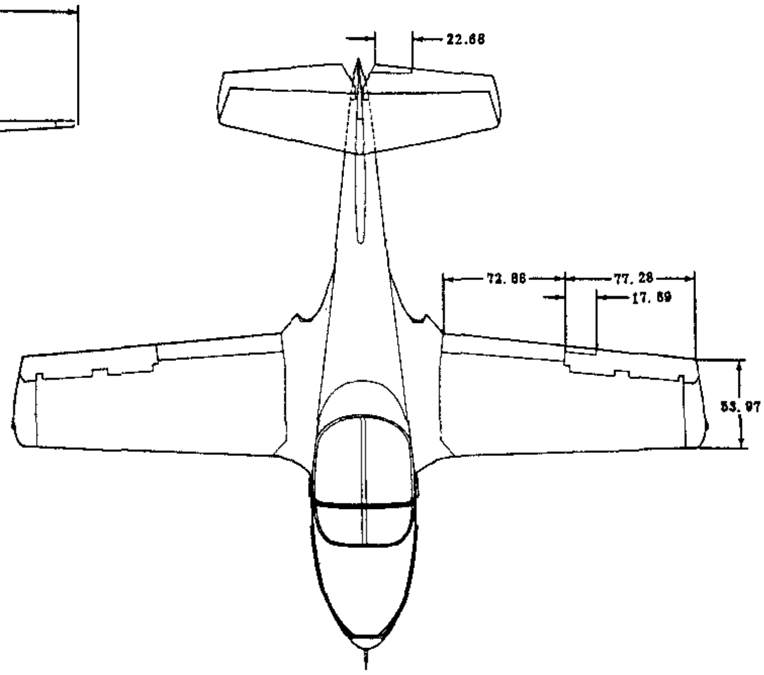
Table B4 Stability and Control Derivatives for Airplane D (Pages 501–507)

Three–view





Reference Geometry

S (ft^2)	182
$\bar{c}$ (ft)	5.47
b (ft)	33.8

Flight Condition Data	Climb	Cruise	Approach
Altitude, h (ft)	0	30,000	0
Mach Number, M	0.313	0.459	0.143
TAS, U_1(ft/sec)	349	456	160
Dynamic pressure, $\bar{q}$ (lbs/ft^2)	144.9	92.7	30.4
C.G. location, fraction $\bar{c}$	27.0	27.0	27.0
Angle of attack, α_1 (deg)	0.7	2	4.2

Mass Data

W (lbs)	6,360	6,360	6,360
I_{xx_B} (slugft2)	7,985	7,985	7,985
I_{yy_B} (slugft2)	3,326	3,326	3,326
I_{zz_B} (slugft2)	11,183	11,183	11,183
I_{xz_B} (slugft2)	0	0	0

Table B4 (Continued) Stability and Control Derivatives for Airplane D (Pages 501–507)

Flight Condition	Climb	Cruise	Approach
Steady State Coefficients			
C_{L_1}	0.241	0.378	1.150
C_{D_1}	0.0220	0.0300	0.1580
$C_{T_{x_1}}$	0.0220	0.0300	0.1580
C_{m_1}	0	0	0
$C_{m_{T_1}}$	0	0	0
Longitudinal Coefficients and Stability Derivatives (Stability Axes, Dimensionless)			
C_{D_0}	0.0200	0.0200	0.0689
C_{D_u}	0	0	0
C_{D_α}	0.130	0.250	0.682
$C_{T_{x_u}}$	–0.05	–0.07	–0.40
C_{L_0}	0.19	0.20	0.81
C_{L_u}	0	0	0
C_{L_α}	4.81	5.15	4.64
$C_{L_{\dot{\alpha}}}$	1.8	2.0	1.8
C_{L_q}	3.7	4.1	3.7
C_{m_0}	0.025	0.025	0.10
C_{m_u}	0	0	0
C_{m_α}	–0.668	–0.700	–0.631
$C_{m_{\dot{\alpha}}}$	–6.64	–6.95	–6.84
C_{m_q}	–14.3	–14.9	–14.0
$C_{m_{T_u}}$	0	0	0
$C_{m_{T_\alpha}}$	0	0	0
Longitudinal Control and Hinge Moment Derivatives (Stability Axes, 1/rad)			
$C_{D_{\delta_e}}$	0	0	0
$C_{L_{\delta_e}}$	0.4	0.5	0.4
$C_{m_{\delta_e}}$	–1.07	–1.12	–1.05
$C_{D_{i_h}}$	not applicable		
$C_{L_{i_h}}$	not applicable		
$C_{m_{i_h}}$	not applicable		

Table B4 (Continued) Stability and Control Derivatives for Airplane D (Pages 501–507)

Flight Condition	Climb	Cruise	Approach
Longitudinal Control and Hinge Moment Derivatives: Cont'd (Stability Axes, 1/rad)			
C_{h_α}	–0.00784	–0.00775	–0.00739
$C_{h_{\delta_e}}$	–0.347	–0.497	–0.347
Lateral–Directional Stability Derivatives (Stability Axes, Dimensionless)			
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
Lateral–Directional Control and Hinge Moment Derivatives (Stability Axes, Dimensionless)			
$C_{l_{\delta_a}}$	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
$C_{h_{\alpha_a}}$	???	???	???
$C_{h_{\delta_a}}$	–0.226	–0.226	–0.226
$C_{h_{\beta_r}}$	0.1146	0.1146	0.1146
$C_{h_{\delta_r}}$	–0.372	–0.372	–0.372

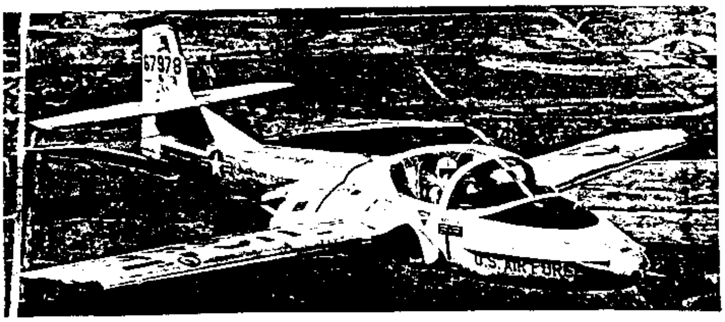


Table B4 (Continued)   Stability and Control Derivatives for Airplane D (Pages 501–507)

Longitudinal Transfer Function Data

Altitude	=	30000	ft
U_1	=	270.14	kts
W_current	=	6360.0	lb
S_w	=	182.[illegible]	ft^2
Theta_1	=	2.00	deg
C_bar	=	5.47	ft
I_yy_B	=	3326	slgft2
C_m_1	=	0.0000	
C_m_u	=	0.0000	
C_m_a	=	-0.7000	1/rad
C_m_a.dot	=	-6.9500	1/rad
C_m_q	=	-14.9000	1/rad
C_m_T_1	=	0.0000	
C_m_T_u	=	0.0000	
C_m_T_a	=	0.0000	
C_L_1	=	0.3780	
C_L_u	=	0.0000	
C_L_a	=	5.1500	1/rad
C_L_a.dot	=	2.0000	1/rad
C_L_q	=	4.1000	1/rad
C_D_1	=	0.0300	
C_D_a	=	0.2500	1/rad
C_D_u	=	0.0000	
C_T_X_1	=	0.0300	
C_T_X_u	=	-0.0700	
C_L_d_e	=	0.5000	1/rad
C_D_d_e	=	0.0000	1/rad
C_m_d_e	=	-1.1200	1/rad

M_1	=	0.458	
n	=	1.00	g
q_bar	=	92.58	psf
(W/S)_TO	=	34.95	psf
X_u	=	-0.0111	1/s
X_T_u	=	-0.0019	1/s
X_a	=	10.8087	ft/s^2
Z_u	=	-0.1400	1/s
Z_a	=	-437.4153	ft/s^2
Z_a_dot	=	-1.0131	ft/s
Z_q	=	-2.0768	ft/s
M_u	=	0.0000	1/ft/s
M_T_u	=	0.0000	1/ft/s
M_a	=	-19.3979	1/s^2
M_T_a	=	0.0000	1/s^2
M_a_dot	=	-1.1553	1/s
M_q	=	-2.4768	1/s
w_n_SP	=	4.6523	rad/s
z_SP	=	0.4927	
w_n_P	=	0.0934	rad/s
z_P	=	0.0526	
X_del_e	=	0.0000	ft/s^2
Z_del_e	=	-42.2216	ft/s^2
M_del_e	=	-31.0366	1/s^2

POLYNOMIAL ANGLE OF ATTACK TO ELEVATOR TRANSFER FUNCTION

```
 - 42.2216 S^3 - 14191.7548 S^2 - 149.4537 S - 137.9759
-----------------------------------------------------------------------------------
 + 456.9617 S^4 + 2099.4660 S^3 + 9914.8881 S^2 + 115.4904 S + 86.2350
```

FACTORED ANGLE OF ATTACK TO ELEVATOR TRANSFER FUNCTION

```
-42.2216  (S + 336.1153)(S^2 + 0.0105 S + 0.0097)
-----------------------------------------------------------------------------------
456.9617  (S^2 + 4.5846 S + 21.6436)(S^2 + 0.0098 S + 0.0087)
```

ANGLE OF ATTACK TO ELEVATOR TRANSFER FUNCTION K_gain = -1.600000

POLYNOMIAL SPEED TO ELEVATOR TRANSFER FUNCTION

```
 - 456.3609 S^2 + 296829.8192 S + 406732.2497
-----------------------------------------------------------------------------------
 + 456.9617 S^4 + 2099.4660 S^3 + 9914.8881 S^2 + 115.4904 S + 86.2350
```

Table B4 (Continued) Stability and Control Derivatives for Airplane D (Pages 501–507)

```
FACTORED SPEED TO ELEVATOR TRANSFER FUNCTION

-456.3609   (S - 651.7952)(S + 1.3674)
-----------------------------------------------------------------------------------
456.9617   (S^2 + 4.5846 S + 21.6436)(S^2 + 0.0098 S + 0.0087)


 SPEED TO ELEVATOR TRANSFER FUNCTION K_gain = 4716.558886


POLYNOMIAL PITCH ATTITUDE TO ELEVATOR TRANSFER FUNCTION

 - 14133.7557 S^2 - 12940.1035 S - 212.3526
-----------------------------------------------------------------------------------
 + 456.9617 S^4 + 2099.4660 S^3 + 9914.8881 S^2 + 115.4904 S + 86.2350


FACTORED PITCH ATTITUDE TO ELEVATOR TRANSFER FUNCTION

-14133.7557   (S + 0.8988)(S + 0.0167)
-----------------------------------------------------------------------------------
456.9617   (S^2 + 4.5846 S + 21.6436)(S^2 + 0.0098 S + 0.0087)


 PITCH ATTITUDE TO ELEVATOR TRANSFER FUNCTION K_gain =   -2.462488
```

Lateral–Directional Transfer Function Data

W_current	=	6360.0	lb
Altitude	=	30000	ft
S_w	=	182.00	ft^2
U_1	=	270.14	kts
Theta_1	=	2.00	deg
Alpha	=	2.00	deg
b_w	=	33.80	ft
I_xx_B	=	7985	slgft2
I_zz_B	=	11183	slgft2
I_xz_B	=	0	slgft2
C_l_B	=	-0.0944	1/rad
C_l_p	=	-0.4420	1/rad
C_l_r	=	0.0926	1/rad
C_n_B	=	0.1106	1/rad
C_n_T_B	=	0.0000	
C_n_p	=	-0.0243	1/rad
C_n_r	=	-0.1390	1/rad
C_y_B	=	-0.3460	1/rad
C_y_p	=	-0.0827	1/rad
C_y_r	=	0.3000	1/rad
C_l_d_a	=	0.1810	1/rad
C_l_d_r	=	0.0150	1/rad
C_n_d_a	=	-0.0254	1/rad
C_n_d_r	=	-0.0365	1/rad
C_y_d_a	=	0.0000	1/rad
C_y_d_r	=	0.2000	1/rad

(W/S)_TO	=	34.95	psf
q_bar	=	92.58	psf
I_xx_S	=	7989	slgft2
I_zz_S	=	11179	slgft2
I_xz_S	=	-112	slgft2
Y_B	=	-29.2173	ft/s^2
Y_p	=	-0.2588	ft/s
Y_r	=	0.9390	ft/s
L_B	=	-6.7297	1/s^2
L_p	=	-1.1679	1/s
L_r	=	0.2447	1/s
N_B	=	5.6345	1/s^2
N_T_B	=	0.0000	1/s^2
N_p	=	-0.0459	1/s
N_r	=	-0.2625	1/s
w_n_D	=	2.4092	rad/s
z_D	=	0.0470	
TC_SPIRAL	=	271.310	s
TC_ROLL	=	0.790	s
TC_1	=	0.790	s
TC_2	=	271.310	s
Y_del_a	=	0.0000	ft/s^2
Y_del_r	=	16.8886	ft/s^2
L_del_a	=	12.9033	1/s^2
L_del_r	=	1.0693	1/s^2
N_del_a	=	-1.2940	1/s^2
N_del_r	=	-1.8595	1/s^2

Table B4 (Continued) Stability and Control Derivatives for Airplane D (Pages 501–507)

POLYNOMIAL SIDESLIP TO AILERON TRANSFER FUNCTION

$$\frac{+ 644.0174\ S^3 + 1367.8551\ S^2 + 97.7970\ S}{+ 455.8852\ S^5 + 682.2214\ S^4 + 2779.2781\ S^3 + 3360.8268\ S^2 + 12.3497\ S}$$

FACTORED SIDESLIP TO AILERON TRANSFER FUNCTION

$$\frac{644.0174\quad S(S + 2.0499)(S + 0.0741)}{455.8852\quad S(S + 1.2663)(S + 0.0037)(S^2 + 0.2265\ S + 5.8041)}$$

SIDESLIP TO AILERON TRANSFER FUNCTION K_gain = 7.918973

POLYNOMIAL SIDESLIP TO RUDDER TRANSFER FUNCTION

$$\frac{+ 16.8863\ S^4 + 874.8441\ S^3 + 1050.7889\ S^2 - 5.5526\ S}{+ 455.8852\ S^5 + 682.2214\ S^4 + 2779.2781\ S^3 + 3360.8268\ S^2 + 12.3497\ S}$$

FACTORED SIDESLIP TO RUDDER TRANSFER FUNCTION

$$\frac{16.8863\quad S(S - 0.0053)(S + 50.5775)(S + 1.2357)}{455.8852\quad S(S + 1.2663)(S + 0.0037)(S^2 + 0.2265\ S + 5.8041)}$$

SIDESLIP TO RUDDER TRANSFER FUNCTION K_gain = -0.449612

POLYNOMIAL ROLL TO AILERON TRANSFER FUNCTION

$$\frac{+ 5891.4614\ S^3 + 1777.3570\ S^2 + 29208.1767\ S}{+ 455.8852\ S^5 + 682.2214\ S^4 + 2779.2781\ S^3 + 3360.8268\ S^2 + 12.3497\ S}$$

FACTORED ROLL TO AILERON TRANSFER FUNCTION

$$\frac{5891.4614\quad S(S^2 + 0.3017\ S + 4.9577)}{455.8852\quad S(S + 1.2663)(S + 0.0037)(S^2 + 0.2265\ S + 5.8041)}$$

ROLL TO AILERON TRANSFER FUNCTION K_gain = 2365.091648

Table B4 (Continued) Stability and Control Derivatives for Airplane D (Pages 501–507)

```
POLYNOMIAL ROLL TO RUDDER TRANSFER FUNCTION

 + 499.3974 S^3 - 162.4592 S^2 - 2964.0008 S
-------------------------------------------------------------------------------
 + 455.8852 S^5 + 682.2214 S^4 + 2779.2781 S^3 + 3360.8268 S^2 + 12.3497 S


FACTORED ROLL TO RUDDER TRANSFER FUNCTION

499.3974   S(S - 2.6043)(S + 2.2790)
-------------------------------------------------------------------------------
455.8852   S(S + 1.2663)(S + 0.0037)(S^2 + 0.2265 S + 5.8041)


 ROLL TO RUDDER TRANSFER FUNCTION K_gain = -240.005862


POLYNOMIAL HEADING TO AILERON TRANSFER FUNCTION

 - 648.6980 S^3 - 1000.5959 S^2 - 78.0196 S + 2038.5145
-------------------------------------------------------------------------------
 + 455.8852 S^5 + 682.2214 S^4 + 2779.2781 S^3 + 3360.8268 S^2 + 12.3497 S


FACTORED HEADING TO AILERON TRANSFER FUNCTION

-648.6980  (S - 1.0733)(S^2 + 2.6158 S + 2.9278)
-------------------------------------------------------------------------------
455.8852   S(S + 1.2663)(S + 0.0037)(S^2 + 0.2265 S + 5.8041)


 HEADING TO AILERON TRANSFER FUNCTION K_gain =  165.065891


POLYNOMIAL HEADING TO RUDDER TRANSFER FUNCTION

 - 852.6958 S^3 - 970.9207 S^2 + 53.1470 S - 206.6877
-------------------------------------------------------------------------------
 + 455.8852 S^5 + 682.2214 S^4 + 2779.2781 S^3 + 3360.8268 S^2 + 12.3497 S


FACTORED HEADING TO RUDDER TRANSFER FUNCTION

-852.6958  (S + 1.3240)(S^2 + -0.1854 S + 0.1831)
-------------------------------------------------------------------------------
455.8852   S(S + 1.2663)(S + 0.0037)(S^2 + 0.2265 S + 5.8041)


 HEADING TO RUDDER TRANSFER FUNCTION K_gain =  -16.736246
```