Includi << ..\Default_Functions.mcdx

LATERAL-DIRECTIONAL PARAMETERS INITIALIZATION

Hidden Area --> Import of Excel INPUT Data

Hidden Area --> Preliminary Mapping of imported Data

Hidden Area --> Import and preliminary mapping of OTHER Excel Data

Other input parameters to be defined here

$C_{Roll} := 0$ $C_N := 0$ $C_{Roll0} := 0$ $C_{N0} := 0$

$\beta := 2\ deg = 0.035$

$p := -0.274\ \frac{deg}{s} = -0.005\ \frac{rad}{s}$

$r := 0.261\ \frac{deg}{s} = 0.005\ \frac{1}{s}$

$p_{bar} := \frac{p \cdot b_W}{2 \cdot V_1} = -0.000313$ $p_{bar} = -0.017912\ deg$

$r_{bar} := \frac{r \cdot b_W}{2 \cdot V_1} = 0.000298$ $r_{bar} = 0.017062\ deg$

LATERAL-DIRECTIONAL PARAMETERS

Input parameters

$mass = (4.5 \cdot 10^4)\ kg$

$C_{D0} = 0.027$

$\Delta Z\_W_{LE}\_Nose = -0.945\ m$

$\Delta X\_W_{LE}\_Nose = 11.125\ m$

$\Delta X\_HT_{LE}\_Nose = 27.859\ m$

$\Delta X\_VT_{LE}\_Nose = 22.296\ m$

$\Delta Z\_HT_{LE}\_Nose = 6.096\ m$

$\Delta Z\_VT_{LE}\_Nose = 1.951\ m$

Imported parameters

$M_1 = 0.696$

$V_1 = 208.41\ \frac{m}{s}$

$p_{dyn} = (8.961 \cdot 10^3)\ Pa$

$Re_{per.unit.len} = (5.902 \cdot 10^6)\ \frac{1}{m}$

$d_B = 2.79\ m$

$Z_1 = 3.69\ m$

$Z_2 = 3.38\ m$

$r_1 = 1.52\ m$

$l_B = 28.16\ m$

$S_{B\_side} = 86.48\ m^2$

$Z_{MAX} = 3.26\ m$

$\omega_{MAX} = 3.26\ m$

$b_V = 4.831\ m$

$C_{L\alpha\_V} = 5.615$

$\eta_V\_times\_1\_plus\_d\sigma\_over\_d\beta = 1.007$

$S_V = 20.54\ m^2$

$X_{MAC\_LE\_V} = 2.383\ m$

$Y_{MAC\_V} = 2.222\ m$

$MAC_V = 4.334\ m$

$\tau_{rd} = 0.68$

$\eta_{rd\_in} = 0$

$\eta_{rd\_out} = 0.656$

$\lambda_V = 0.613$

$\eta_V = 0.97$

$MAC_H = 2.433\ m$

$\alpha_{0L\_H} = 0\ deg$

$S_H = 25.47\ m^2$

$\eta_H = 0.95$

$AR_H = 4.94$

$b_H = 11.217\ m$

$\Lambda_{H\_c2} = 27.147\ deg$

$\lambda_H = 0.367$

$\Lambda_{H\_c4} = 31.238\ deg$

$\Gamma_H = 0\ deg$

$\alpha_{0l\_H\_r} = 0\ deg$

$\alpha_{0l\_H\_t} = 0\ deg$

$C_L = 0.562$

$\alpha_{WB} = 3.186\ deg$

$C_{LH} = -0.114$

$N_{eng\_1} = 2$

$N_{eng\_2} = 0$

$N_{eng} = 2$

$S_{eng} = 1.14\ m^2$

$C_{N\alpha\_eng} = 0.334$

$x_{CG} = 1.002\ m$

$\Delta X\_CG\_eng_1 = -5.35\ m$

$\Delta X\_CG\_eng_2 = 0\ m$

$\Delta X\_CG\_Nose = 14.99\ m$

$\Delta Z\_W_{c4\_r}\_B_{CL} = -0.894\ m$

$\Delta Z\_HT_{c4\_r}\_B_{CL} = -7.724\ m$

$MAC_W = 3.642\ m$

$X_{MAC\_LE\_W} = 2.861\ m$

$b_W = 27.249\ m$

$C_{L\alpha\_W} = 0.109\ deg^{-1}$

$i_W = 2\ deg$

$\Lambda_{W\_c4\_eqv} = 28.018\ deg$

$\xi_{ac\_W} = 16.788\ deg$

$S_W = 87.62\ m^2$

$AR_W = 8.474$

$e_W = 0.918$

$\Lambda_{W\_c2\_eqv} = 20.97\ deg$

$\lambda_W = 0.227$

$\lambda_{W\_eqv} = 0.227$

$\Gamma_{W\_eqv} = 2.177\ deg$

$\alpha_{0l\_W\_r} = -0.047$

$\alpha_{0l\_W\_t} = -0.047$

$X_{ac\_W} = 3.928\ m$

$c_{W\_r} = 5.243\ m$

$\eta_{aileron\_in} = 0.664$

$\eta_{aileron\_out} = 0.908$

$c_{aileron} = 0.792\ m$

$Z_{MAC\_W} = 0.207\ m$

$c_{W\_mean\_@a} = 2.056\ m$

ENGINES CONTRIBUTION

$C_{Y\beta} := C_{N\alpha\_eng}$

$C_{Y\beta} = 0.006\ deg^{-1}$

$C_{N\beta\_eng\_1} := -C_{Y\beta} \cdot \dfrac{S_{eng}}{S_W} \cdot \dfrac{\Delta X\_CG\_eng_1}{MAC_W} \cdot \dfrac{N_{eng\_1}}{N_{eng}} = 0.006$

$C_{N\beta\_eng\_1} = \left(1.114 \cdot 10^{-4}\right)\ deg^{-1}$

$C_{N\beta\_eng\_2} := -C_{Y\beta} \cdot \dfrac{S_{eng}}{S_W} \cdot \dfrac{\Delta X\_CG\_eng_2}{MAC_W} \cdot \dfrac{N_{eng\_2}}{N_{eng}} = 0$

$C_{N\beta\_eng\_2} = 0\ deg^{-1}$

- **REMARK: This is the Yawing Moment Coefficient due to sideslip angle**

LATERAL-DIRECTIONAL CALCULATIONS

Wing - Body - Horizontal Tail - Vertical Tail Dihedral Effect

$S_{fAVG} := \pi \cdot d_B \cdot \left(\dfrac{Z_1 + Z_2}{2}\right) = 30.984\ m^2$

$S_{fAVG} = 30.984\ m^2$

$\Delta C_{Roll\beta\_over\_\Gamma_W} := -\dfrac{(0.0005)}{deg^2} \cdot AR_W \cdot \left(\left(\dfrac{\sqrt{\dfrac{4 \cdot S_{fAVG}}{\pi}}}{b_W}\right)^2\right) = -0.739$

$\Delta C_{Roll\beta\_over\_\Gamma_W} = -2.251 \cdot 10^{-4}\ \dfrac{1}{deg^2}$

$\Delta C_{Roll\beta\_over\_\Gamma_H} := -\dfrac{(0.0005)}{deg^2} \cdot AR_H \cdot \left(\left(\dfrac{\sqrt{\dfrac{4 \cdot S_{fAVG}}{\pi}}}{b_H}\right)^2\right) = -2.542$

$\Delta C_{Roll\beta\_over\_\Gamma_H} = -7.745 \cdot 10^{-4}\ \dfrac{1}{deg^2}$

$\Delta C_{Roll\beta\_ZW} := \dfrac{1.2 \cdot \sqrt{AR_W}}{57.3} \cdot \dfrac{\Delta Z\_W_{c4\_r}\_B_{CL}}{b_W} \cdot 2 \cdot \dfrac{\sqrt{\dfrac{4 \cdot S_{fAVG}}{\pi}}}{b_W} \cdot \dfrac{1}{deg} = -0.053$

$\Delta C_{Roll\beta\_ZW} = -9.221 \cdot 10^{-4}\ \dfrac{1}{deg}$

$\Delta C_{Roll\beta\_ZH} := \dfrac{1.2 \cdot \sqrt{AR_H}}{57.3} \cdot \dfrac{\Delta Z\_HT_{c4\_r}\_B_{CL}}{b_H} \cdot 2 \cdot \dfrac{\sqrt{\dfrac{4 \cdot S_{fAVG}}{\pi}}}{b_H} \cdot \dfrac{1}{deg} = -2.057$

$\Delta C_{Roll\beta\_ZH} = -6.265 \cdot 10^{-4}\ \dfrac{1}{deg^2}$

@Aerodynamic Database ---> (C_l_beta_w_b)_k_M_Gamma_vs_Mach_times_cos(L_c2)_(AR_over_cos(L_c2))

$K_{M\Gamma\_W} = 1.157$

$K_{M\Gamma\_H} = 1.091$

@Aerodynamic Database ---> (C_l_beta_w_b)_C_l_beta_over_Gamma_w_vs_AR_(L_c2)_(lambda)

$C_{Roll\beta}\_over\_\Gamma_W = -0.59$

$C_{Roll\beta}\_over\_\Gamma_W = -1.799 \cdot 10^{-4}\ deg^{-2}$

$C_{Roll\beta}\_over\_\Gamma_H = -0.51$

$C_{Roll\beta}\_over\_\Gamma_H = -1.554 \cdot 10^{-4}\ deg^{-2}$

@Aerodynamic Database ---> (C_l_beta_w_b)_dC_l_beta_over_eps_w_times_tan_(L_c4)_vs_AR_(lambda)

$\Delta C_{Roll\beta}\_over\_\varepsilon_W\_times\_tan\Lambda c4_W = -0.117$

$\Delta C_{Roll\beta}\_over\_\varepsilon_W\_times\_tan\Lambda c4_W = -3.572 \cdot 10^{-5}\ deg^{-2}$

$\Delta C_{Roll\beta}\_over\_\varepsilon_H\_times\_tan\Lambda c4_H = -0.106$

$\Delta C_{Roll\beta}\_over\_\varepsilon_H\_times\_tan\Lambda c4_H = -3.217 \cdot 10^{-5}\ deg^{-2}$

@Aerodynamic Database ---> (C_l_beta_w_b)_C_l_beta_over_C_Lift1_(L_c2)_vs_L_c2_(AR)_(lambda)

$C_{Roll\beta W}\_over\_C_L@\Lambda_{c2} = -0.106$

$C_{Roll\beta W}\_over\_C_L@\Lambda_{c2} = -1.848 \cdot 10^{-3}\ deg^{-1}$

$C_{Roll\beta H}\_over\_C_L@\Lambda_{c2} = -0.132$

$C_{Roll\beta H}\_over\_C_L@\Lambda_{c2} = -2.307 \cdot 10^{-3}\ deg^{-1}$

@Aerodynamic Database ---> (C_l_beta_w_b)_C_l_beta_over_C_Lift1_(L_c2)_vs_L_c2_(AR)_(lambda)

$C_{Roll\beta W}\_over\_C_L@AR_W = 0.015$

$C_{Roll\beta W}\_over\_C_L@AR_W = \left(2.553 \cdot 10^{-4}\right)\ deg^{-1}$

$C_{Roll\beta H}\_over\_C_L@AR_H = -0.047$

$C_{Roll\beta H}\_over\_C_L@AR_H = -8.135 \cdot 10^{-4}\ deg^{-1}$

@Aerodynamic Database ---> (C_l_beta_w_b)_k_M_L_vs_Mach_times_cos(L_c2)_(AR_over_cos(L_c2))

$K_{M\_\Lambda W} = 1.263$

$K_{M\_\Lambda H} = 1.115$

@Aerodynamic Database ---> (C_l_beta_w_b)_k_M_L_vs_Mach_times_cos(L_c2)_(AR_over_cos(L_c2))

$A_W := \Delta X\_W_{LE}\_Nose + \frac{b_W}{2} \cdot \tan\left(\Lambda_{W\_c2\_eqv}\right) = 16.347\ m$ $\quad A_W = 16.347\ m$

$A_H := \Delta X\_HT_{LE}\_Nose + \frac{b_H}{2} \cdot \tan\left(\Lambda_{H\_c2}\right) = 30.735\ m$ $\quad A_H = 30.735\ m$

$K_{fW} = 0.884$ $\quad K_{fH} = 0.909$

Wing - Body - Horizontal Tail - Vertical Tail Dihedral Effect Calculations

$C_{Roll\beta\_WB\_\Lambda\_c2\_AR} := C_L \cdot \left(C_{Roll\beta W}\_over\_C_L@\Lambda_{c2} \cdot K_{M\_\Lambda W} \cdot K_{fW} + C_{Roll\beta W}\_over\_C_L@AR_W\right) = -0.058$

$C_{Roll\beta\_WB\_\Gamma\_W\_eqv} := C_L \cdot \Gamma_{W\_eqv} \cdot \left(C_{Roll\beta}\_over\_\Gamma_W \cdot K_{M\Gamma\_W} + \Delta C_{Roll\beta}\_over\_\Gamma_W\right) = -0.03$

$C_{Roll\beta\_WB\_\varepsilon\_W} := C_L \cdot \left(\Delta C_{Roll\beta\_ZW} + \left(\alpha_{0l\_W\_t} - \alpha_{0l\_W\_r}\right) \cdot \tan\left(\Lambda_{W\_c4\_eqv}\right) \cdot \Delta C_{Roll\beta}\_over\_\varepsilon_W\_times\_tan\Lambda c4_W\right) = -0.03$

$C_{Roll\beta\_WB} := C_{Roll\beta\_WB\_\Lambda\_c2\_AR} + C_{Roll\beta\_WB\_\Gamma\_W\_eqv} + C_{Roll\beta\_WB\_\varepsilon\_W} = -0.118$

$C_{Roll\beta\_WB} = -0.118$ $\quad C_{Roll\beta\_WB} = -0.00206\ deg^{-1}$

$C_{Roll\beta\_H\_\Lambda\_c2\_AR} := \eta_H \cdot \frac{S_H}{S_W} \cdot \frac{b_H}{b_W} \cdot C_{LH} \cdot \left(C_{Roll\beta H}\_over\_C_L@\Lambda_{c2} \cdot K_{M\_\Lambda H} \cdot K_{fH} + C_{Roll\beta H}\_over\_C_L@AR_H\right) = 0.002$

$C_{Roll\beta\_H\_\Gamma\_H} := \eta_H \cdot \frac{S_H}{S_W} \cdot \frac{b_H}{b_W} \cdot C_{LH} \cdot \Gamma_H \cdot \left(C_{Roll\beta}\_over\_\Gamma_H \cdot K_{M\Gamma\_H} + \Delta C_{Roll\beta}\_over\_\Gamma_H\right) = 0$

$C_{Roll\beta\_H\_\varepsilon\_H} := \eta_H \cdot \frac{S_H}{S_W} \cdot \frac{b_H}{b_W} \cdot C_{LH} \cdot \left(\Delta C_{Roll\beta\_ZH} + \left(\alpha_{0l\_H\_t} - \alpha_{0l\_H\_r}\right) \cdot \tan\left(\Lambda_{H\_c4}\right) \cdot \Delta C_{Roll\beta}\_over\_\varepsilon_H\_times\_tan\Lambda c4_H\right) = 0.027$

$C_{Roll\beta\_H} := C_{Roll\beta\_H\_\Lambda\_c2\_AR} + C_{Roll\beta\_H\_\Gamma\_H} + C_{Roll\beta\_H\_\varepsilon\_H} = 0.029$

$C_{Roll\beta\_H} = 0.029$ $\quad C_{Roll\beta\_H} = \left(5.065 \cdot 10^{-4}\right)\ deg^{-1}$

$\Delta X\_VT_{ac}\_CG := \Delta X\_VT_{LE}\_Nose + X_{MAC\_LE\_V} + \frac{MAC_V}{4} - \Delta X\_CG\_Nose = 10.773\ m$

$X_V := \Delta X\_VT_{ac}\_CG = 10.773\ m$

$\Delta Z\_VT_{ac}\_W_{ac} := Y_{MAC\_V} + \Delta Z\_VT_{LE}\_Nose - \Delta Z\_W_{LE}\_Nose - Z_{MAC\_W} = 4.911\ m$ $\quad \Delta Z\_VT_{ac}\_W_{ac} = 4.911\ m$

$\Delta Z\_VT_{ac}\_CG := \Delta Z\_VT_{ac}\_W_{ac} + \Delta Z\_W_{LE}\_Nose \cdot \frac{X_{ac\_W}}{c_{W\_r} \cdot \cos\left(i_W\right)} = 4.202\ m$

$Z_V := \Delta Z\_VT_{ac}\_CG = 4.202\ m$

@Aerodynamic Database ---> (C_y_beta_v)_K_Y_V_vs_b_v_over_2_times_r1

$K_{Y\_V} = 0.76$

$$C_{Roll\beta\_V} := -K_{Y\_V} \cdot C_{L\alpha\_V} \cdot \eta_V\_times\_1\_plus\_d\sigma\_over\_d\beta \cdot \frac{S_V}{S_W} \cdot \frac{Z_V \cdot \cos(\alpha_{WB}) - X_V \cdot \sin(\alpha_{WB})}{b_W} = -0.133$$

$$C_{Roll\beta} := C_{Roll\beta\_WB} + C_{Roll\beta\_H} + C_{Roll\beta\_V} = -0.222 \qquad C_{Roll\beta} = -0.00388\ deg^{-1}$$

Wing - Body - Horizontal Tail - Vertical Tail Rolling Moment Coefficient due to Ailerons Deflection

$$k_M := \frac{C_{L\alpha\_W} \cdot \sqrt{1 - M_1^{\ 2}}}{2 \cdot \pi} = 0.712 \qquad \Lambda_M := \operatorname{atan}\left(\frac{\tan(\Lambda_{W\_c4\_eqv})}{\sqrt{1 - M_1^{\ 2}}}\right) = 36.54\ deg$$

$$\beta\_times\_AR\_over\_k := \frac{\sqrt{1 - M_1^{\ 2}} \cdot AR_W}{k_M} = 8.55$$

@Aerodynamic Database ---> (C_l_delta_a)_RME_vs_eta_(Lambda_beta)_(beta_times_AR_over_k)_(lambda)

$RME_{in} = 0.461$ $\qquad$ $RME_{out} = 0.662$

$$\Delta RME := RME_{out} - RME_{in} = 0.2$$

$$C_{Roll\delta}' := -\frac{\Delta RME \cdot k_M}{\sqrt{1 - M_1^{\ 2}}} = -0.1986$$

@Aerodynamic Database ---> (control_surface)_tau_e_vs_c_control_surface_over_c_horizontal_tail

$\tau_a = 0.597$

$$C_{Roll\delta a} := C_{Roll\delta}' \cdot \tau_a = -0.119 \qquad C_{Roll\delta a} = -0.002\ \frac{1}{deg}$$

Wing - Body - Horizontal Tail - Vertical Tail Rolling Moment Coefficient due to Rudder Deflection

$$Z_r := 0.95 \cdot Z_V = 3.992\ m \qquad X_r := 1.05 \cdot X_V = 11.311\ m$$

@Aerodynamic Database ---> (C_n_delta_r)_K_R_vs_eta_(lambda_v)

$K_r = 0.787$

$$C_{Roll\delta r} := C_{L\alpha\_V} \cdot \eta_V \cdot \frac{S_V}{S_W} \cdot K_r \cdot \tau_{rd} \cdot \left(\frac{Z_r \cdot \cos(\alpha_{WB}) - X_r \cdot \sin(\alpha_{WB})}{b_W}\right) = 0.084$$

Wing - Body - Horizontal Tail - Vertical Tail Yawing Moment Coefficient due to Sideslip Angle

$C_{N\beta\_W} := 0$ $C_{N\beta\_H} := 0$

@Aerodynamic Database ---> (C_n_beta_b)_K_N_times_1e-3_vs_x_cg_over_l_b_(squared_l_b_over_S_b_s)_(square_root_(h1_over_h2))_(h_b_over_w_b)

$K_N = 0.001$

@Aerodynamic Database ---> (C_n_beta_b)_K_Re_b_vs_Re_l_b_times_1e-6

$Re_{l\_B} := Re_{per.unit.len} \cdot l_B = 1.662 \cdot 10^{8}$

$K_{Re\_B} = 2.025$

$C_{N\beta\_B} := -57.3 \cdot K_N \cdot K_{Re\_B} \cdot \dfrac{S_{B\_side}}{S_W} \cdot \dfrac{l_B}{b_W} = -0.155$ $C_{N\beta\_B} = -0.003 \dfrac{1}{deg}$

$C_{N\beta\_V} := K_{Y\_V} \cdot C_{L\alpha\_V} \cdot \eta_{V}\_times\_1\_plus\_d\sigma\_over\_d\beta \cdot \dfrac{S_V}{S_W} \cdot \dfrac{Z_V \cdot \sin(\alpha_{WB}) + X_V \cdot \cos(\alpha_{WB})}{b_W} = 0.406$ $C_{N\beta\_V} = 0.007 \dfrac{1}{deg}$

$C_{N\beta} := C_{N\beta\_W} + C_{N\beta\_H} + C_{N\beta\_B} + C_{N\beta\_V} + C_{N\beta\_eng\_1} + C_{N\beta\_eng\_2} = 0.257$ $C_{N\beta} = 0.004 \dfrac{1}{deg}$

Wing - Body - Horizontal Tail - Vertical Tail Yawing Moment Coefficient due to Ailerons Deflection

@Aerodynamic Database ---> (C_n_delta_a)_k_n_a_vs_eta_(AR)_(lambda)

$\Delta K_{n\_A} = 0.024$

$C_{N\delta a} := -\Delta K_{n\_A} \cdot C_L \cdot C_{Roll\delta a} = 0.002$ $C_{N\delta a} = \left(2.809 \cdot 10^{-5}\right) \dfrac{1}{deg}$

Wing - Body - Horizontal Tail - Vertical Tail Yawing Moment Coefficient due to Rudder Deflection

$C_{N\delta r} := -C_{L\alpha\_V} \cdot \eta_V \cdot \dfrac{S_V}{S_W} \cdot K_r \cdot \tau_{rd} \cdot \left(\dfrac{Z_r \cdot \sin(\alpha_{WB}) + X_r \cdot \cos(\alpha_{WB})}{b_W}\right) = -0.289$ $C_{N\delta r} = -5.039 \cdot 10^{-3} \dfrac{1}{deg}$

UNSTEADY LATERAL-DIRECTIONAL FLIGHT COEFFICIENTS

Wing - Body - Horizontal Tail - Vertical Tail   Rolling Moment Coefficient due to Roll Rate

$$k_{Roll\_Rate\_W} := \frac{C_{L\alpha\_W} \cdot \sqrt{1 - M_1^{\,2}}}{2 \cdot \pi} = 0.712$$

$$k_{Roll\_Rate\_H} := \frac{C_{L\alpha\_H} \cdot \sqrt{1 - M_1^{\,2}}}{2 \cdot \pi} = 0.53$$

@Aerodynamic Database ---> (C_l_p_w)_RDP_vs_Lambda_beta_(beta_times_AR_over_k)_(lambda)

$RDP_W = -0.404$ $RDP_H = -0.375$

$$C_{Rollp\_W} := RDP_W \cdot \frac{k_{Roll\_Rate\_W}}{\sqrt{1 - M_1^{\,2}}} = -0.401$$

$$C_{Rollp\_H} := \frac{1}{2} \cdot RDP_H \cdot \frac{k_{Roll\_Rate\_H}}{\sqrt{1 - M_1^{\,2}}} \cdot \frac{S_H}{S_W} \cdot \left(\frac{b_H}{b_W}\right)^2 = -0.007$$

$$C_{Rollp\_V} := -2 \cdot K_{Y\_V} \cdot C_{L\alpha\_V} \cdot \eta_V\_times\_1\_plus\_d\sigma\_over\_d\beta \cdot \frac{S_V}{S_W} \cdot \left(\frac{Z_V}{b_W}\right)^2 = -47.917 \cdot 10^{-3}$$

$$C_{Rollp} := C_{Rollp\_W} + C_{Rollp\_H} + C_{Rollp\_V} = -0.456$$

Wing - Body - Horizontal Tail - Vertical Tail   Yawing Moment Coefficient due to Roll Rate

$$B := -\frac{1}{6} \cdot \frac{AR_W + 6 \cdot \left(AR_W + \cos\left(\Lambda_{W\_c4\_eqv}\right)\right) \cdot \left(\left(\xi_{CG} - \xi_{ac\_W}\right) \cdot \frac{\tan\left(\Lambda_{W\_c4\_eqv}\right)}{AR_W} + \frac{\tan\left(\Lambda_{W\_c4\_eqv}\right)^2}{12}\right)}{AR_W + \cos\left(\Lambda_{W\_c4\_eqv}\right)} = -0.173$$

$$C_{Np}\_over\_C_L@M_0\_C_{L\_ZL} := \frac{B}{\sqrt{1 - M_1^{\,2} \cdot \cos\left(\Lambda_{W\_c4\_eqv}\right)^2}} = -0.22$$

$$C := \frac{AR_W + 4 \cdot \cos\left(\Lambda_{W\_c4\_eqv}\right)}{AR_W \cdot B + 4 \cdot \cos\left(\Lambda_{W\_c4\_eqv}\right)} \cdot \frac{AR_W \cdot B + 0.5 \cdot \left(AR_W \cdot B + 4 \cdot \cos\left(\Lambda_{W\_c4\_eqv}\right) \cdot \tan\left(\Lambda_{W\_c4\_eqv}\right)^2\right)}{AR_W + 0.5 \cdot \left(AR_W \cdot B + 4 \cdot \cos\left(\Lambda_{W\_c4\_eqv}\right) \cdot \tan\left(\Lambda_{W\_c4\_eqv}\right)^2\right)} = -1.204$$

$$C_{Np}\_over\_C_L@M_1\_C_{L\_ZL} := C \cdot C_{Np}\_over\_C_L@M_0\_C_{L\_ZL} = 0.265$$

@Aerodynamic Database ---> (C_n_p_w)_dC_n_p_over_eps_w_vs_AR_(lambda)

$\Delta C_{Np}\_over\_\varepsilon_W = 5.315 \cdot 10^{-4}$

$$C_{Np\_W} := -C_{Rollp\_W} \cdot \tan\left(\alpha_{WB}\right) + C_{Rollp} \cdot \tan\left(\alpha_{WB}\right) + C_{Np\_over\_C_L@M_1\_C_{L\_ZL}} \cdot C_L + \Delta C_{Np\_over\_\varepsilon_W} \cdot \left(\alpha_{0l\_W\_t} - \alpha_{0l\_W\_r}\right) = 0.146$$

$$C_{Np\_V} := -2 \cdot K_{Y\_V} \cdot C_{L\alpha\_V} \cdot \eta_{V\_times\_1\_plus\_d\sigma\_over\_d\beta} \cdot \frac{S_V}{S_W} \cdot \left(\frac{Z_V \cdot \sin\left(\alpha_{WB}\right) + X_V \cdot \cos\left(\alpha_{WB}\right)}{b_W}\right) \cdot \left(\frac{Z_V \cdot \cos\left(\alpha_{WB}\right) - X_V \cdot \sin\left(\alpha_{WB}\right) - Z_V}{b_W}\right)$$

$$C_{Np\_V} = 18.045 \cdot 10^{-3}$$

$$C_{Np} := C_{Np\_W} + C_{Np\_V} = 0.164$$

Wing - Body - Horizontal Tail - Vertical Tail   Rolling Moment Coefficient due to Yaw Rate

$$B := \sqrt{1 - M_1^{\,2} \cdot \cos\left(\Lambda_{W\_c4\_eqv}\right)^2} = 0.789$$

$$D := \frac{1 + \dfrac{AR_W \cdot \left(1 - B^2\right)}{2 \cdot B \cdot \left(AR_W \cdot B + 2 \cdot \cos\left(\Lambda_{W\_c4\_eqv}\right)\right)} + \dfrac{AR_W \cdot B + 2 \cdot \cos\left(\Lambda_{W\_c4\_eqv}\right)}{AR_W \cdot B + 4 \cdot \cos\left(\Lambda_{W\_c4\_eqv}\right)} \cdot \dfrac{\tan\left(\Lambda_{W\_c4\_eqv}\right)^2}{8}}{1 + \dfrac{AR_W + 2 \cdot \cos\left(\Lambda_{W\_c4\_eqv}\right)}{AR_W + 4 \cdot \cos\left(\Lambda_{W\_c4\_eqv}\right)} \cdot \dfrac{\tan\left(\Lambda_{W\_c4\_eqv}\right)^2}{8}} = 1.232$$

@Aerodynamic Database ---> (C_l_r_w)_C_l_r_over_C_Lift1_vs_AR_(lambda)_(L_c2)

$$C_{Rollr\_over\_C_L@M_0\_C_{L\_ZL}} = 0.299$$

$$C_{Rollr\_over\_C_L@M_1\_C_{L\_ZL}} := D \cdot C_{Rollr\_over\_C_L@M_0\_C_{L\_ZL}} = 0.369$$

$$\Delta C_{Rollr\_over\_\Gamma} := \frac{1}{12} \cdot \frac{\pi \cdot AR_W \cdot \sin\left(\Lambda_{W\_c4\_eqv}\right)}{AR_W + 4 \cdot \cos\left(\Lambda_{W\_c4\_eqv}\right)} = 0.087$$

@Aerodynamic Database ---> (C_l_r_w)_dC_l_r_over_eps_w_vs_AR_(lambda)

$$\Delta C_{Rollr\_over\_\varepsilon} = 0.014$$

$$C_{Rollr\_W} := C_{Rollr\_over\_C_L@M_1\_C_{L\_ZL}} \cdot C_L + \Delta C_{Rollr\_over\_\Gamma} \cdot \Gamma_{W\_eqv} + \Delta C_{Rollr\_over\_\varepsilon} \cdot \left(\alpha_{0l\_W\_t} - \alpha_{0l\_W\_r}\right) = 0.211$$

$$C_{Rollr\_V} := -2 \cdot K_{Y\_V} \cdot C_{L\alpha\_V} \cdot \eta_{V\_times\_1\_plus\_d\sigma\_over\_d\beta} \cdot \frac{S_V}{S_W} \cdot \left(\frac{Z_V \cdot \sin\left(\alpha_{WB}\right) + X_V \cdot \cos\left(\alpha_{WB}\right)}{b_W}\right) \cdot \left(\frac{Z_V \cdot \cos\left(\alpha_{WB}\right) - X_V \cdot \sin\left(\alpha_{WB}\right) - Z_V}{b_W}\right)$$

$$C_{Rollr\_V} = 18.045 \cdot 10^{-3}$$

$$C_{Rollr} := C_{Rollr\_W} + C_{Rollr\_V} = 0.229$$

Wing - Body - Horizontal Tail - Vertical Tail   Yawing Moment Coefficient due to Yaw Rate

@Aerodynamic Database ---> (C_n_r_w)_C_n_r_over_squared_(C_Lift1)_vs_AR_(lambda)_(L_c4)_(x_bar_ac_minus_x_bar_cg)

$C_{Nr}\_over\_squared\_C_L = 0.227$

@Aerodynamic Database ---> (C_n_r_w)_C_n_r_over_C_D0_bar_vs_AR_(L_c4)_(x_bar_ac_minus_x_bar_cg)

$C_{Nr}\_over\_C_{D0} = -0.419$

$$C_{Nr\_W} := C_{Nr}\_over\_squared\_C_L \cdot {C_L}^2 + C_{Nr}\_over\_C_{D0} \cdot C_{D0} = 0.06$$

$$C_{Nr\_V} := -2 \cdot K_{Y\_V} \cdot C_{L\alpha\_V} \cdot \eta_V\_times\_1\_plus\_d\sigma\_over\_d\beta \cdot \frac{S_V}{S_W} \cdot \left(\frac{Z_V \cdot \sin\left(\alpha_{WB}\right) + X_V \cdot \cos\left(\alpha_{WB}\right)}{b_W} \right)^2 = -0.328$$

$$C_{Nr} := C_{Nr\_W} + C_{Nr\_V} = -0.267$$

Equilibrium system solution and results

$\delta_a = -2.408$ ***deg*** $\delta_{rd} = 1.743$ ***deg***

MAPPING AND OUTPUT CREATION

Includi << ..\Default_Map_Lateral_Directional.mcdx

Excel Writing

$n_{sheet} := 7$

$First\_Row_{LD\_1} := 4$

$Block_{LD\_1} := {}_{f}\mathrm{map\_matrix\_transform}\left({}_{m}LatDir\_Data\_Map_{imported}\right)$

$Excel\_Output_{LD\_1} := {}_{f}\mathrm{write\_full\_output}\left({}_{s}Output\_Excel\_File, Block_{LD\_1}, n_{sheet}, First\_Row_{LD\_1}\right)$

$First\_Row_{LD\_2} := First\_Row_{LD\_1} + \mathrm{rows}\left(Block_{LD\_1}\right) + 2$

$Block_{LD\_2} := {}_{f}\mathrm{map\_matrix\_transform}\left({}_{m}LatDir\_Data\_Map_{input}\right)$

$Excel\_Output_{LD\_2} := {}_{f}\mathrm{write\_full\_output}\left({}_{s}Output\_Excel\_File, Block_{LD\_2}, n_{sheet}, First\_Row_{LD\_2}\right)$

$First\_Row_{LD\_3} := First\_Row_{LD\_2} + \mathrm{rows}\left(Block_{LD\_2}\right) + 2$

$Block_{LD\_3} := {}_{f}\mathrm{map\_matrix\_transform}\left({}_{m}LatDir\_Data\_Map\right)$

$Excel\_Output_{LD\_3} := {}_{f}\mathrm{write\_full\_output}\left({}_{s}Output\_Excel\_File, Block_{LD\_3}, n_{sheet}, First\_Row_{LD\_3}\right)$

TeX Macro writing on .tex

${}_{v}complete\_macros_{LD} := \mathrm{stack}\left(Block_{LD\_1}^{\langle 2\rangle}, Block_{LD\_2}^{\langle 2\rangle}, Block_{LD\_3}^{\langle 2\rangle}\right)$

${}_{v}tex_{LD} := {}_{f}\mathrm{write\_matrix}\left(\text{“.\textbackslash Output\textbackslash LATERAL\_DIRECTIONAL\_TeX\_Macros.tex”}, {}_{v}complete\_macros_{LD}, \text{“ ”}\right)$