$with(LinearAlgebra):$

$M := Matrix([[\alpha + 2\,\beta\cos(\theta\_2), \delta + \beta\cos(\theta\_2)], [\delta + \beta\cos(\theta\_2), \delta]]);$

$$M := \begin{bmatrix} \alpha + 2\,\beta\cos(\theta\_2) & \delta + \beta\cos(\theta\_2) \\ \delta + \beta\cos(\theta\_2) & \delta \end{bmatrix} \tag{1}$$

$C := Matrix([[-\beta\, w\_2\sin(\theta\_2), -\beta\cdot(w\_1 + w\_2)\sin(\theta\_2)], [\beta\, w\_1\sin(\theta\_2), 0]]);$

$$C := \begin{bmatrix} -\beta\, w\_2\sin(\theta\_2) & -\beta\,(w\_1 + w\_2)\sin(\theta\_2) \\ \beta\, w\_1\sin(\theta\_2) & 0 \end{bmatrix} \tag{2}$$

$B := Matrix([[b\_11, b\_12], [b\_21, b\_22]]);$

$$B := \begin{bmatrix} b\_11 & b\_12 \\ b\_21 & b\_22 \end{bmatrix} \tag{3}$$

$\tau := Matrix([[\tau\_1], [\tau\_2]]);$

$$\tau := \begin{bmatrix} \tau\_1 \\ \tau\_2 \end{bmatrix} \tag{4}$$

$dot\theta := Matrix([[w\_1], [w\_2]]);$

$$dot\theta := \begin{bmatrix} w\_1 \\ w\_2 \end{bmatrix} \tag{5}$$

$RHS := \tau - MatrixMatrixMultiply((C + B), dot\theta);$

$$RHS := \begin{bmatrix} \tau\_1 - (-\beta\, w\_2\sin(\theta\_2) + b\_11)\, w\_1 - (-\beta\,(w\_1 + w\_2)\sin(\theta\_2) + b\_12)\, w\_2 \\ \tau\_2 - (\beta\, w\_1\sin(\theta\_2) + b\_21)\, w\_1 - b\_22\, w\_2 \end{bmatrix} \tag{6}$$

$N := MatrixInverse(M);$

$$N := \begin{bmatrix} -\dfrac{\delta}{\cos(\theta\_2)^2\beta^2 - \alpha\,\delta + \delta^2} & \dfrac{\delta + \beta\cos(\theta\_2)}{\cos(\theta\_2)^2\beta^2 - \alpha\,\delta + \delta^2} \\ \dfrac{\delta + \beta\cos(\theta\_2)}{\cos(\theta\_2)^2\beta^2 - \alpha\,\delta + \delta^2} & -\dfrac{\alpha + 2\,\beta\cos(\theta\_2)}{\cos(\theta\_2)^2\beta^2 - \alpha\,\delta + \delta^2} \end{bmatrix} \tag{7}$$

$dotw := MatrixMatrixMultiply(N, RHS);$

$$dotw := [[\tag{8}$$

$$-\frac{1}{\cos(\theta\_2)^2\beta^2 - \alpha\,\delta + \delta^2}\left(\delta\,(\tau\_1 - (-\beta\, w\_2\sin(\theta\_2) + b\_11)\, w\_1 - (-\beta\,(w\_1 + w\_2)\sin(\theta\_2) + b\_12)\, w\_2)\right)$$

$$+\frac{(\delta+\beta\cos(\theta\_2))\,(\tau\_2-(\beta\,w\_1\sin(\theta\_2)+b\_21)\,w\_1-b\_22\,w\_2)}{\cos(\theta\_2)^2\beta^2-\alpha\delta+\delta^2}\Bigg],$$

$$\Bigg[\frac{1}{\cos(\theta\_2)^2\beta^2-\alpha\delta+\delta^2}\big((\delta+\beta\cos(\theta\_2))\,(\tau\_1-(-\beta\,w\_2\sin(\theta\_2)+b\_11)\,w\_1$$

$$-(-\beta\,(w\_1+w\_2)\sin(\theta\_2)+b\_12)\,w\_2)\big)$$

$$-\frac{(\alpha+2\beta\cos(\theta\_2))\,(\tau\_2-(\beta\,w\_1\sin(\theta\_2)+b\_21)\,w\_1-b\_22\,w\_2)}{\cos(\theta\_2)^2\beta^2-\alpha\delta+\delta^2}\Bigg]\Bigg]$$

$dotw1 := dotw([1]);$

$$dotw1 := \Bigg[\tag{9}$$

$$-\frac{1}{\cos(\theta\_2)^2\beta^2-\alpha\delta+\delta^2}\big(\delta\,(\tau\_1-(-\beta\,w\_2\sin(\theta\_2)+b\_11)\,w\_1-(-\beta\,(w\_1$$

$$+w\_2)\sin(\theta\_2)+b\_12)\,w\_2)\big)$$

$$+\frac{(\delta+\beta\cos(\theta\_2))\,(\tau\_2-(\beta\,w\_1\sin(\theta\_2)+b\_21)\,w\_1-b\_22\,w\_2)}{\cos(\theta\_2)^2\beta^2-\alpha\delta+\delta^2}\Bigg]$$

$dotw2 := dotw([2]);$

$$dotw2 := \Bigg[\frac{1}{\cos(\theta\_2)^2\beta^2-\alpha\delta+\delta^2}\big((\delta+\beta\cos(\theta\_2))\,(\tau\_1-(-\beta\,w\_2\sin(\theta\_2) \tag{10}$$

$$+b\_11)\,w\_1-(-\beta\,(w\_1+w\_2)\sin(\theta\_2)+b\_12)\,w\_2)\big)$$

$$-\frac{(\alpha+2\beta\cos(\theta\_2))\,(\tau\_2-(\beta\,w\_1\sin(\theta\_2)+b\_21)\,w\_1-b\_22\,w\_2)}{\cos(\theta\_2)^2\beta^2-\alpha\delta+\delta^2}\Bigg]$$

$L1 := diff(dotw1, \theta\_1);$

$$L1 := [\ 0\ ] \tag{11}$$

$L2 := diff(dotw1, \theta\_2);$

$$L2 := \Bigg[-\frac{1}{(\cos(\theta\_2)^2\beta^2-\alpha\delta+\delta^2)^2}\big(2\,\delta\,(\tau\_1-(-\beta\,w\_2\sin(\theta\_2)+b\_11)\,w\_1-(\tag{12}$$

$$-\beta\,(w\_1+w\_2)\sin(\theta\_2)+b\_12)\,w\_2)\cos(\theta\_2)\,\beta^2\sin(\theta\_2)\big)$$

$$-\frac{\delta\,(\beta\,w\_2\cos(\theta\_2)\,w\_1+\beta\,(w\_1+w\_2)\cos(\theta\_2)\,w\_2)}{\cos(\theta\_2)^2\beta^2-\alpha\delta+\delta^2}$$

$$- \frac{\beta \sin(\theta\_2) \left(\tau\_2 - (\beta w\_1 \sin(\theta\_2) + b\_21) w\_1 - b\_22 w\_2\right)}{\cos(\theta\_2)^2 \beta^2 - \alpha \delta + \delta^2}$$

$$+ \frac{1}{\left(\cos(\theta\_2)^2 \beta^2 - \alpha \delta + \delta^2\right)^2} \Big(2 (\delta + \beta \cos(\theta\_2)) \left(\tau\_2 - (\beta w\_1 \sin(\theta\_2)\right.$$

$$\left. + b\_21) w\_1 - b\_22 w\_2\right) \cos(\theta\_2) \beta^2 \sin(\theta\_2)\Big)$$

$$\left. - \frac{(\delta + \beta \cos(\theta\_2)) \beta w\_1^2 \cos(\theta\_2)}{\cos(\theta\_2)^2 \beta^2 - \alpha \delta + \delta^2} \right]$$

$L3 := diff(dotw1, w\_1);$

$$L3 := \tag{13}$$

$$\left[- \frac{\delta (2 \beta w\_2 \sin(\theta\_2) - b\_11)}{\cos(\theta\_2)^2 \beta^2 - \alpha \delta + \delta^2} + \frac{(\delta + \beta \cos(\theta\_2)) (-2 \beta w\_1 \sin(\theta\_2) - b\_21)}{\cos(\theta\_2)^2 \beta^2 - \alpha \delta + \delta^2} \right]$$

$L4 := diff(dotw1, w\_2);$

$$L4 := \left[- \frac{\delta (\beta w\_1 \sin(\theta\_2) + \beta w\_2 \sin(\theta\_2) + \beta (w\_1 + w\_2) \sin(\theta\_2) - b\_12)}{\cos(\theta\_2)^2 \beta^2 - \alpha \delta + \delta^2} \right. \tag{14}$$

$$\left. - \frac{(\delta + \beta \cos(\theta\_2)) b\_22}{\cos(\theta\_2)^2 \beta^2 - \alpha \delta + \delta^2} \right]$$

$M1 := diff(dotw2, \theta\_1);$

$$M1 := \left[\, 0 \, \right] \tag{15}$$

$M2 := diff(dotw2, \theta\_2);$

$$M2 := \left[- \frac{1}{\cos(\theta\_2)^2 \beta^2 - \alpha \delta + \delta^2} \Big(\beta \sin(\theta\_2) \big(\tau\_1 - (-\beta w\_2 \sin(\theta\_2) + b\_11) w\_1 - (\right. \tag{16}$$

$$-\beta (w\_1 + w\_2) \sin(\theta\_2) + b\_12) w\_2\big)\Big) + \frac{1}{\left(\cos(\theta\_2)^2 \beta^2 - \alpha \delta + \delta^2\right)^2} \Big(2 (\delta$$

$$+ \beta \cos(\theta\_2)) \big(\tau\_1 - (-\beta w\_2 \sin(\theta\_2) + b\_11) w\_1 - (-\beta (w\_1 + w\_2) \sin(\theta\_2)$$

$$+ b\_12) w\_2\big) \cos(\theta\_2) \beta^2 \sin(\theta\_2)\Big)$$

$$+ \frac{(\delta + \beta \cos(\theta\_2)) (\beta w\_2 \cos(\theta\_2) w\_1 + \beta (w\_1 + w\_2) \cos(\theta\_2) w\_2)}{\cos(\theta\_2)^2 \beta^2 - \alpha \delta + \delta^2}$$

$$+\frac{2\,\beta\sin(\theta\_2)\,\left(\tau\_2-(\beta\,w\_1\sin(\theta\_2)+b\_21)\,w\_1-b\_22\,w\_2\right)}{\cos(\theta\_2)^2\,\beta^2-\alpha\,\delta+\delta^2}$$

$$-\frac{1}{\left(\cos(\theta\_2)^2\,\beta^2-\alpha\,\delta+\delta^2\right)^2}\Big(2\,(\alpha+2\,\beta\cos(\theta\_2))\,\big(\tau\_2-(\beta\,w\_1\sin(\theta\_2)$$

$$+b\_21)\,w\_1-b\_22\,w\_2\big)\cos(\theta\_2)\,\beta^2\sin(\theta\_2)\Big)$$

$$+\left.\frac{(\alpha+2\,\beta\cos(\theta\_2))\,\beta\,w\_1^2\cos(\theta\_2)}{\cos(\theta\_2)^2\,\beta^2-\alpha\,\delta+\delta^2}\right]$$

$M3 := diff(dotw2, w\_1);$

$$M3 := \left[\frac{(\delta+\beta\cos(\theta\_2))\,(2\,\beta\,w\_2\sin(\theta\_2)-b\_11)}{\cos(\theta\_2)^2\,\beta^2-\alpha\,\delta+\delta^2}\right. \tag{17}$$

$$\left.-\frac{(\alpha+2\,\beta\cos(\theta\_2))\,(-2\,\beta\,w\_1\sin(\theta\_2)-b\_21)}{\cos(\theta\_2)^2\,\beta^2-\alpha\,\delta+\delta^2}\right]$$

$M4 := diff(dotw2, w\_2);$

$$M4 := \tag{18}$$

$$\left[\frac{1}{\cos(\theta\_2)^2\,\beta^2-\alpha\,\delta+\delta^2}\big((\delta+\beta\cos(\theta\_2))\,(\beta\,w\_1\sin(\theta\_2)+\beta\,w\_2\sin(\theta\_2)\right.$$

$$\left.+\beta\,(w\_1+w\_2)\sin(\theta\_2)-b\_12)\big)+\frac{(\alpha+2\,\beta\cos(\theta\_2))\,b\_22}{\cos(\theta\_2)^2\,\beta^2-\alpha\,\delta+\delta^2}\right]$$

$detN := \cos(\theta\_2)^2\,\beta^2-\alpha\,\delta+\delta^2;$

$$detN := \cos(\theta\_2)^2\,\beta^2-\alpha\,\delta+\delta^2 \tag{19}$$

$ddetN := diff(detN, \theta\_2);$

$$ddetN := -2\cos(\theta\_2)\,\beta^2\sin(\theta\_2) \tag{20}$$