restart

#Initialize linear algebra
with(*LinearAlgebra*) :
with(*VectorCalculus*) :
with(*ArrayTools*) :
with(*CodeGeneration*) :

#Import expressions from other worksheets:

read "../Impact_map/impact_map.m";

#Compute Jacobian of impact map:

 # Impact map for velocities
$Pq := MatrixInverse(rhs(Qp0)).rhs(Qn0);$
 # Map for positions
$P := Matrix([[0, 1], [1, 0]]);$

#Computing Jacobian of complete updating law
$qn := Vector([q1n, q2n]) :$
$Dqn := Vector([Dq1n, Dq2n]) :$

$qp := P.qn :$
$Dqp := subs(q1 = qn(1), q2 = qn(2), Pq).Dqn :$

$dF := simplify(Jacobian([qp(1), qp(2), Dqp(1), Dqp(2)], [qn(1), qn(2), Dqn(1), Dqn(2)]));$

#Define impact surface gradients:

$BasisFormat(false) :$
$S := \cos(q1 + \mathrm{psi}) - \cos(q2 + \mathrm{psi}) = 0 ;$
$Sn := subs(q1 = qn(1), q2 = qn(2), lhs(S));$
$nn := Vector([diff(Sn, qn(1)), diff(Sn, qn(2)), 0, 0]);$
$Sp := subs(q1 = \mathrm{q2n}, q2 = \mathrm{q1n}, lhs(S));$
$np := Vector([diff(Sp, q1n), diff(Sp, q2n), 0, 0]);$

#Define transformation matrix L:

#Using linearization of y, Dy, I expressions

$$L := Matrix\left(\left[\left[-2\cdot DDq1, 0, 2\cdot Dq1, 0\right], \left[-\frac{Dq2}{Dq1}, 1, 0, 0\right], \left[-\frac{\left(DDq2 - \frac{Dq2}{Dq1}\cdot DDq1\right)}{Dq1^2}\cdot Dq1, 0, -\frac{Dq2}{Dq1}, 1\right]\right]\right);$$

$Lp := subs(q1 = q1p, q2 = q2p, Dq1 = Dq1p, Dq2 = Dq2p, DDq1 = DDq1p, DDq2 = DDq2p, L);$

$Ln := subs(q1 = q1n, q2 = q2n, Dq1 = Dq1n, Dq2 = Dq2n, DDq1 = DDq1n, DDq2 = DDq2n, L);$

#Define flow vector m:

$$m := Vector([Dq1, Dq2, DDq1, DDq2]);$$
$$mp := subs(Dq1 = Dq1p, Dq2 = Dq2p, DDq1 = DDq1p, DDq2 = DDq2p, m);$$
$$mn := subs(Dq1 = Dq1n, Dq2 = Dq2n, DDq1 = DDq1n, DDq2 = DDq2n, m);$$

#Compute projection matrices:

$$Pn := simplify\left(\left(IdentityMatrix(4) - \frac{mn.Transpose(nn)}{Transpose(mn).nn}\right).MatrixInverse(Concatenate(1, Ln, Transpose(mn))).Concatenate\left(1, IdentityMatrix(3), Vector_{row}([0, 0, 0])\right)\right);$$

$$Pp := simplify\left(Lp.\left(IdentityMatrix(4) - \frac{mp.Transpose(np)}{Transpose(mp).np}\right)\right);$$

#Complete linearization of impact map:

$$dF\_TS := Pp.dF.Pn;$$

#Creating Matlab code:

$$Matlab\left(dF\_TS_{1,1}, resultname = 'df\_ts11'\right):$$
$$Matlab\left(dF\_TS_{1,2}, resultname = 'df\_ts12'\right):$$
$$Matlab\left(dF\_TS_{1,3}, resultname = 'df\_ts13'\right):$$

$$Matlab\left(dF\_TS_{2,1}, resultname = 'df\_ts21'\right):$$
$$Matlab\left(dF\_TS_{2,2}, resultname = 'df\_ts22'\right):$$
$$Matlab\left(dF\_TS_{2,3}, resultname = 'df\_ts23'\right):$$

$$Matlab\left(dF\_TS_{3,1}, resultname = 'df\_ts31'\right):$$
$$Matlab\left(dF\_TS_{3,2}, resultname = 'df\_ts32'\right):$$
$$Matlab\left(dF\_TS_{3,3}, resultname = 'df\_ts33'\right):$$