```
> with(MBSymba_r6):
  with(LinearAlgebra):
```

RECURSIVE APPROACH

```
> P0    := origin(ground):
  printf("\nReference frame 1"):
  RF1   := translate(x1 + s(t),y1,0);
  P1    := origin(RF1):
  Gact  := P1:
  #Gact  := make_POINT(ground,x1 + (s(t)+L1)/2,y1,0):
  P01   := make_POINT(ground,x1,y1,0):
```

```
> printf("\nReference frame 2"):
  RF2   := RF1.translate(L1,0,0).rotate('Z',theta1(t));
  P2    := origin(RF2):
  P3    := make_POINT(RF2,LP,0,0):
  Gpod  := make_POINT(RF2,LP/2,0,0):
```

$$RF2 := \begin{bmatrix} \cos(\theta 1(t)) & -\sin(\theta 1(t)) & 0 & L1 + x1 + s(t) \\ \sin(\theta 1(t)) & \cos(\theta 1(t)) & 0 & y1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (1)$$

```
> printf("\nReference frame 3"):
  RF3 := translate(x4,y4,0).rotate('Z',theta3(t));
  P4  := origin(RF3):
  P5  := make_POINT(RF3,LF,0,0):
  RF3_CoM := combine(RF3.rotate('Z',psi));

  Gflap  := make_POINT(RF3_CoM,LFb,0,0):
  P3b    := make_POINT(RF3,anc,0,0):
```

$$RF3 := \begin{bmatrix} \cos(\theta 3(t)) & -\sin(\theta 3(t)) & 0 & x4 \\ \sin(\theta 3(t)) & \cos(\theta 3(t)) & 0 & y4 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$RF3\_CoM := \begin{bmatrix} \cos(\theta 3(t) + \psi) & -\sin(\theta 3(t) + \psi) & 0 & x4 \\ \sin(\theta 3(t) + \psi) & \cos(\theta 3(t) + \psi) & 0 & y4 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (2)$$

Constraint equations

Check the DOFs of the system

Analytic solution

List of dependent and independent coordinate

```
> q_I := {theta3(t)}:
  q_D := q_vars minus q_I;
```

$$q\_D := \{s(t), \theta 1(t)\} \tag{3.1}$$

Analytic solution

```
> printf("Analytic solution"):
  sol_kine_all := op(solve(Phi, convert(q_D,list), explicit=true)): <%>;
```

$$\left[\left[s(t) = \right.\right. \tag{3.2}$$

$$-LP$$

$$\left(\frac{1}{LP^2} \left(-\sin(\theta 3(t))^2 anc^2 + 2\sin(\theta 3(t))\, anc\, y1 - 2\sin(\theta 3(t))\, anc\, y4 + LP^2 \right.\right.$$

$$\left.\left. - y1^2 + 2\, y1\, y4 - y4^2 \right) \right)^{1/2} + \cos(\theta 3(t))\, anc - L1 - x1 + x4 \Bigg],$$

$$\left[\theta 1(t) = \arcsin\left(\frac{\sin(\theta 3(t))\, anc - y1 + y4}{LP} \right) \right]\Bigg]$$

```
> sol_kine := simplify(sol_kine_all):
> read("./lib/kinematics/OPTIMIZATION.maplet"):
> read("./lib/kinematics/PVAanalysis.maplet"):
```