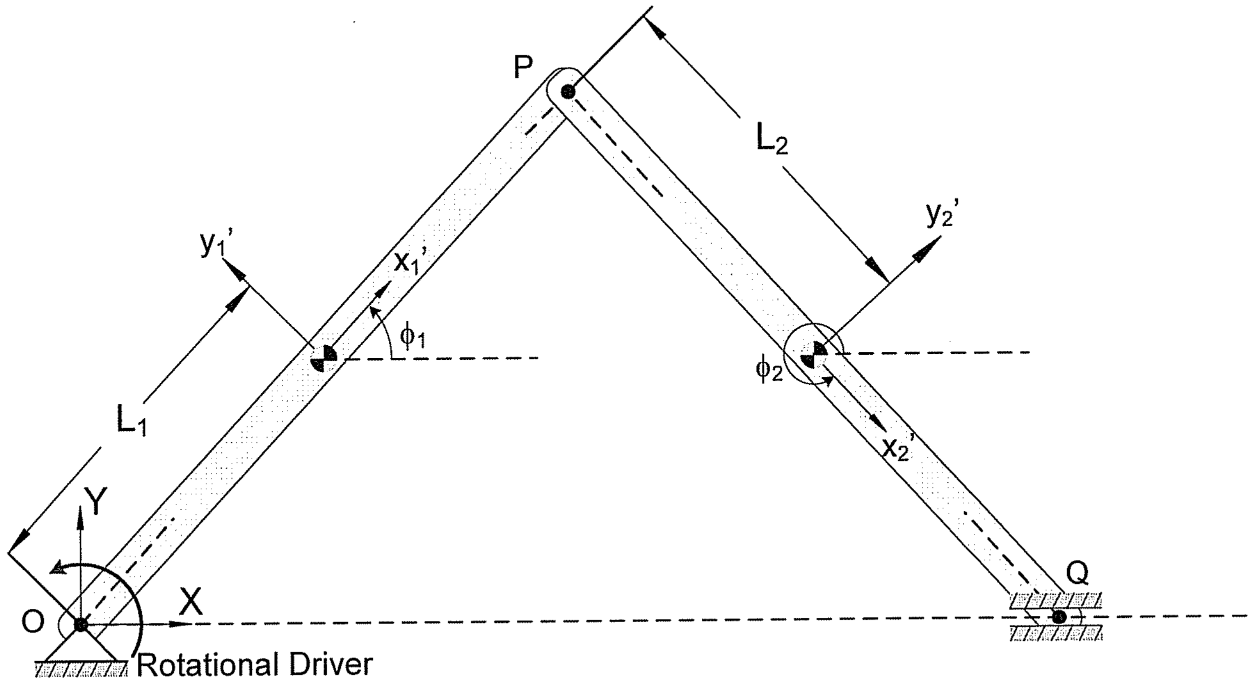
EXAMPLE – 2 BODY SLIDER CRANK



For this problem assume that $L_1 = 1.5$ & $L_2 = 2$. All units are S.I.

For the sake of generating an adm file use

$m_1 = 1 \quad \bar{J}_1 = 0.5 \qquad m_2 = 1.5 \quad \bar{J}_2 = 1$

Assume that a rotational driver is specified that turns body 1 with a constant angular velocity of 2π rad/sec.

For this mechanism

a) Specify the set of kinematic and driving constraints

b) For each kinematic/driving constraint at a) above specify the set of atributes that define the constraint

c) Generate an adm file associated with this mechanism and its prescribed motion

For this problem use a full cartesian set of generalized coordinates:

$$q = \begin{bmatrix} q_1 \\ q_2 \end{bmatrix} = \begin{bmatrix} r_1 \\ \varphi_1 \\ r_2 \\ \varphi_2 \end{bmatrix} = \begin{bmatrix} x_1 \\ y_1 \\ \varphi_1 \\ x_2 \\ y_2 \\ \varphi_2 \end{bmatrix}$$

a) Kinematic constraints:

1) Absolute x for point O on body 1 ⟼ 1 eq.

2) Absolute y ———— " ———— ⟼ 1 eq.

3) Revolute joint at point P between bodies 1 & 2 ⟼ 2 eq.

4) Absolute y for point Q on body 2 ⟼ 1 eq.

Driving constraints:

5) Absolute angle motion on body 1 ⟼ 1 eq.

Note that we have a set of six generalized coordinates and six constraints ⇒ NDOF = 0 ⇒ one can do a kinematic analysis of this mechanism.

b) Attributes of the constraints:

1) Coordinates of point O in the LRF of body 1:

$$\bar{s}^O = \begin{bmatrix} -1.5 \\ 0 \end{bmatrix}$$

coordinates of point O in the GRF :

$$r^O = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Motion : NONE

2) Identical to 1) above

3) $$\bar{s}_1^P = \begin{bmatrix} 1.5 \\ 0 \end{bmatrix} \qquad \bar{s}_2^P = \begin{bmatrix} -2 \\ 0 \end{bmatrix}$$

MOTION : NONE

4) $\bar{s}_2^{Q} = \begin{bmatrix} 2 \\ 0 \end{bmatrix}$ $y^{Q} = 0$ (coordinate of Q in GRF)

MOTION prescribed : none.

5) The angular velocity is 2π rad/sec $\Rightarrow$ $\varphi_1(t) = 2\pi t$

Therefore, we have the following set of attributes.

MOTION : $2\pi t$

c) ADM file provided on next page

NOTE:

In the ADM file, the mass, mass moment of inertia, and initial position and configuration of the bodies is basically irrelevant.

However, the initial position that you provide will be used as a starting point by the Newton-Raphson method when used to get the position of the mechanism at $t=0$.

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%  Define the bodies present in the model   %%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Body: 1                  % id of this body
Mass: 1                  % mass of body
Jbar: 0.4                % mass moment of inertia
xZero: 1.5               % initial X position
yZero: 0                 % initial Y position
phiZero: 0               % initial orientation (this is pi/2)
xDotZero: 0.0            % initial velX
yDotZero: 9.42477796     % initial velY; this is 3*pi
phiDotZero: 6.28318531   % initial velPhi
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Body: 2                    % id of this body
Mass: 1.5                  % mass of body
Jbar: 1                    % mass moment of inertia
xZero: 5                   % initial X position
yZero: 0                   % initial Y position
phiZero: 0                 % initial orientation (this is pi/2)
xDotZero: 0.0              % initial velX
yDotZero: 4.71238898       % initial velY; this is 1.5*pi
phiDotZero: 6.28318531     % initial velPhi
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%  Define the constraints of the model %%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
AbsoluteX: 1            % id of this constraint
Body: 1                 % id of participating body
xPprime: -1.5           % x of point P on moving body, expressed in LRF
yPprime: 0              % y of point P on moving body, expressed in LRF
xPground: 0             % x of point P on ground
yPground: 0             % y of point P on ground
CmotionFunction: NONE   % provides expression for C(t)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
AbsoluteY: 2            % id of this constraint
Body: 1                 % id of participating body
xPprime: -1.5           % x of point P on moving body, expressed in LRF
yPprime: 0              % y of point P on moving body, expressed in LRF
xPground: 0             % x of point P on ground
yPground: 0             % y of point P on ground
CmotionFunction: NONE   % provides expression for C(t)
```

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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
RevoluteJoint: 3        % id of this constraint
BodyI: 1                % id of body I
BodyJ: 2                % id of body J
xPprimeI: 1.5           % x of point P on body I
yPprimeI: 0             % y of point P on body I
xPprimeJ: -2            % x of point P on body J
yPprimeJ: 0             % y of point P on body J
CmotionFunction: NONE   % provides expression for C(t)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
AbsoluteY: 4             % id of this constraint
Body: 2                  % id of participating body
xPprime: 2               % x of point P on moving body, expressed in LRF
yPprime: 0               % y of point P on moving body, expressed in LRF
xPground: 0              % x of point P on ground
yPground: 0              % y of point P on ground
CmotionFunction: NONE    % provides expression for C(t)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
AbsoluteAngle: 5            % id of this constraint
Body: 1                     % id of body the constraint refers to
CmotionFunction: 2*pi*t     % provides expression for C(t)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%  END OF ADM FILE  %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```