GUI FOR VARIABLE STROKE MECHANISM

A Project Report Submitted to Amrita School of Engineering (Chennai) in partial fulfilment of the Requirements for the Degree of Bachelor of Technology in Computer Science and Engineering (Artificial Intelligence)

COMPUTATIONAL ENGINEERING MECHANICS - 2 (19PHY113)

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IN

ARTIFICIAL INTELLIGENCE

AMRITA SCHOOL OF ENGINEERING, CHENNAI

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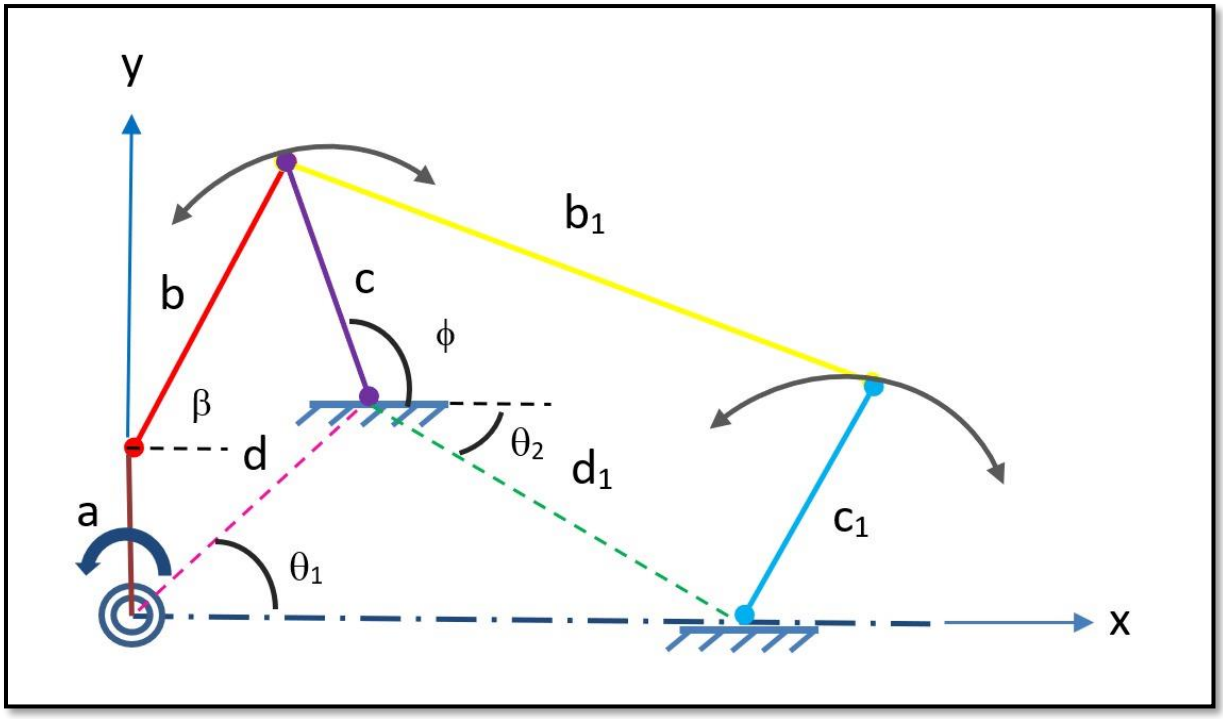
DESCRIPTION OF MECHANISM : VARIABLE STROKE MECHANISM

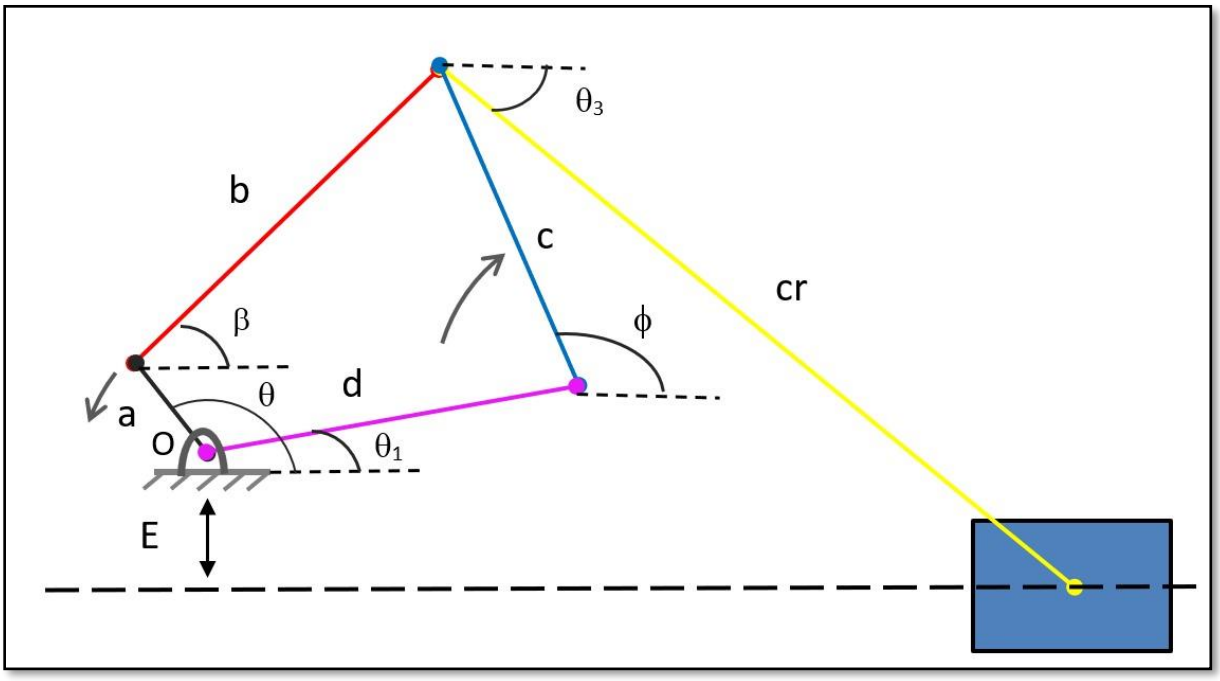
TYPE 1:



The above mechanism is a variable stroke mechanism(Type 1). This can be attained by the combination of 2 four-bar mechanism .

In this Variable stroke mechanism, the output link of the first loop (1st four-bar mechanism that is the rocker) will act as the input link for the second loop (2nd four-bar mechanism).

TYPE 2:



This is the combination of a four-bar mechanism and slider crank mechanism.

Here, the four-bar mechanism is a crank rocker mechanism, the rocker of the four bar mechanism acts as the crank for the slider crank mechanism in loop 2

TYPE 1:

PARAMETER NOTATIONS

a=Crank (1^{st} loop)

b=Coupler(1^{st} loop)

c=Rocker(1^{st} loop)

d=Ground link(1^{st} loop)

b1=Coupler (2^{nd} loop)

c1=Rocker (2^{nd} loop)

d1=Ground (2^{nd} loop)

β = Coupler angle made with X − axis(1^{st} loop)

φ = Output link angle made with X − axis(1^{st} loop)

β_1 = Coupler angle made with X − axis(2^{nd} loop)

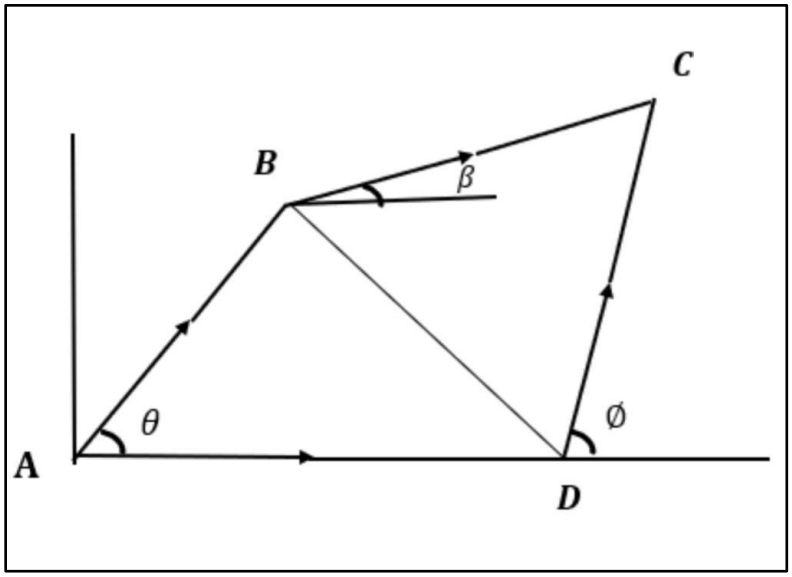
φ_1 = Output link angle made with X − axis(2^{nd} loop)

θ_1 = Inclination made by the ground link(1^{st} loop)

θ_2 = Inclination made by the ground link (2^{nd} loop)

θ=Crank angle (Which varies from 0^0-360^0)

POSITION ANALYSIS:



Displacement in X- Axis

$a * \mathrm{Cos}(\theta) + b * Cos(\beta) = c * Cos(\varphi) + \mathrm{d} * \mathrm{Cos}(\theta_1)$

$b * Cos(\beta) = c * Cos(\varphi) + \mathrm{d} * \mathrm{Cos}(\theta_1) - a * \mathrm{Cos}(\theta)$→EQ (1)

Squaring on both sides

$b^2 * Cos^2(\beta) = c^2 * Cos^2(\varphi) + d^2 * Cos^2(\theta_1) + a^2 * Cos^2(\theta) - 2 * a * c * Cos(\theta) * Cos(\varphi) - 2 * a * d * Cos(\theta) * Cos(\theta_1) + 2 * c * d * Cos(\varphi) * Cos(\theta_1)$→EQ (2)

Displacement in y-axis

$a * \sin(\theta) + b * \sin(\beta) = c * \sin(\varphi) + \mathrm{d} * \mathrm{Sin}(\theta_1)$→EQ (3)

$b * \sin(\beta) = c * \sin(\varphi) - a * \sin(\theta) + \mathrm{d} * \mathrm{Sin}(\theta_1)$

Squaring on both sides

$b^2 * sin^2(\beta) = c^2 * sin^2(\varphi) + a^2 * sin^2(\theta) + d^2 * sin^2(\theta_1) - 2 * a * c * \sin(\theta) * \sin(\varphi) + 2 * c * d * \sin(\theta) * \sin(\theta_1) - 2 * a * d * \sin(\theta) * \sin(\theta_1)$→EQ (4)

Adding EQ (2)andEQ (4),

$b^2 * [sin^2(\beta) + Cos^2(\beta)] = a^2 + c^2 + d^2 - 2 * a * c * Cos(\theta) * Cos(\varphi) -$

$2 * a * d * Cos(\theta) * Cos(\theta_1) + 2 * c * d * Cos(\varphi) * Cos(\theta_1) - 2 * a * c * Sin(\theta) * Sin(\varphi)$

$+2 * c * d * Sin(\varphi) * Sin(\theta_1) - 2 * a * d * Sin(\theta) * Cos(\theta_1)$

For **Angle φ,**

Let, $a^2 + d^2 + c^2 - b^2 = 2K$→EQ (5)

$$2 * K - 2 * a * c * Cos(\theta) * Cos(\varphi) - 2 * a * d * Cos(\theta) * Cos(\theta_1) + 2 * c * d * Cos(\varphi) * Cos(\theta_1) - 2 * a * c * Sin(\theta) * Sin(\varphi) + 2 * c * d * Sin(\varphi) * Sin(\theta_1) - 2 * a * d * Sin(\theta) * Cos(\theta_1) = 0$$

Dividing the above equation by 2

$$K - a * c * Cos(\theta) * Cos(\varphi) - a * d * Cos(\theta) * Cos(\theta_1) + c * d * Cos(\varphi) * Cos(\theta_1) - a * c * Sin(\theta) * Sin(\varphi) + c * d * Sin(\varphi) * Sin(\theta_1) - a * d * Sin(\theta) * Cos(\theta_1) = 0$$

$$\sin(\varphi) = \left[\frac{2\tan\left(\frac{\varphi}{2}\right)}{1 + tan^2\left(\frac{\varphi}{2}\right)}\right]$$

$$\cos(\varphi) = \left[\frac{1 - tan^2\left(\frac{\varphi}{2}\right)}{1 + tan^2\left(\frac{\varphi}{2}\right)}\right]$$

$$K - a * c * Cos(\theta) * \left[\frac{1 - tan^2\left(\frac{\varphi}{2}\right)}{1 + tan^2\left(\frac{\varphi}{2}\right)}\right] - a * d * Cos(\theta) * Cos(\theta_1) + c * d * Cos(\theta_1) * \left[\frac{1 - tan^2\left(\frac{\varphi}{2}\right)}{1 + tan^2\left(\frac{\varphi}{2}\right)}\right] - a * c * Sin(\theta) * \left[\frac{2\tan\left(\frac{\varphi}{2}\right)}{1 + tan^2\left(\frac{\varphi}{2}\right)}\right] + c * d * Sin(\theta_1) * \left[\frac{2\tan\left(\frac{\varphi}{2}\right)}{1 + tan^2\left(\frac{\varphi}{2}\right)}\right] - a * d * Sin(\theta) * Cos(\theta_1) = 0$$

Now multiplying $\left[1 + tan^2\left(\frac{\varphi}{2}\right)\right]$ on both sides:

On segregating the terms of $\left[tan^2\left(\frac{\varphi}{2}\right)\right]$ and $\left[\tan\left(\frac{\varphi}{2}\right)\right]$ we get a quadratic equation as: -

$$[k - a * d * Sin(\theta) * Sin(\theta_1) - a * d * Cos(\theta) * Cos(\theta_1) - c * d * Cos(\theta_1) + a * c * Cos(\theta)]tan^2\left(\frac{\varphi}{2}\right) + [2 * c * d * sind(\theta_1) - 2 * a * c * \sin(\theta)] * \tan\left(\frac{\varphi}{2}\right) + [k - a * d * Sin(\theta) * Sin(\theta_1) - a * d * Cos(\theta) * Cos(\theta_1) + c * d * Cos(\theta_1) - a * c * Cos(\theta)] = 0$$

→EQ (6)

Let

$$A = k - a * d * \sin(\theta) * Sin(\theta_1) - a * \cos(\theta)\,[d * Cos(\theta_1) - c] - c * d * Cos(\theta_1)$$

$$B = 2[a * c * Sin(\theta_1) - a * c * \sin(\theta)]$$

$$C = k - a * d * \sin(\theta) * Sin(\theta_1) - a * \cos(\theta)\,[d * Cos(\theta_1) + c] + c * d * Cos(\theta_1)$$

On rewriting EQ-6,

$$A\,tan^2\left(\frac{\varphi}{2}\right) + B\tan\left(\frac{\varphi}{2}\right) + C = 0$$

$\tan\left(\frac{\varphi}{2}\right) = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$

$$\boxed{\varphi = 2tan^{-1}\left[\frac{-B \pm \sqrt{B^2 - 4AC}}{2A}\right]}$$

For **angle $\boldsymbol{\beta}$,**

$c * \text{Cos}(\varphi) = a * Cos(\theta) + b * Cos(\beta) - d * Cos(\theta_1)$→Rewriting EQ (1)

Squaring on both sides

$c^2 * Cos^2(\varphi) = a^2 * Cos^2(\theta) + d^2 * Cos^2(\theta_1) + b^2 * Cos^2(\beta) - 2 * a * d * Cos(\theta) * Cos(\theta_1) - 2 * b * d * Cos(\beta) * Cos(\theta_1) + 2 * a * b * Cos(\varphi) * Cos(\theta_1)$→EQ (7)

$c * \text{Sin}(\varphi) = a * Sin(\theta) + b * Sin(\beta) - d * Sin(\theta_1)$→Rewriting EQ (3)

Squaring on both sides,

$c^2 * Sin^2(\varphi) = a^2 * Sin^2(\theta) + d^2 * Sin^2(\theta_1) + b^2 * Sin^2(\beta) - 2 * a * d * Sin(\theta) * Sin(\theta_1) - 2 * b * d * Sin(\beta) * Sin(\theta_1) + 2 * a * b * Sin(\varphi) * Sin(\theta_1)$→EQ (8)

Adding both equations,

$c^2[sin^2(\varphi) + cos^2(\varphi)] = a^2 + b^2 + d^2 + 2 * a * b * \text{Cos}(\theta) * \text{Cos}(\beta) - 2 * b * d * Cos(\beta) * Cos(\theta_1) - 2 * a * d * Cos(\theta) * Cos(\theta_1) + 2 * a * b * Sin(\theta) * Sin(\beta) - 2 * a * d * Sin(\theta) * Sin(\theta_1) - 2 * b * d * Sin(\beta) * Sin(\theta_1)$→EQ (9)

Let, $a^2 + b^2 + d^2 - c^2 = 2G$

$$2G + 2 * a * b * \text{Cos}(\theta) * \text{Cos}(\beta) - 2 * b * d * Cos(\beta) * Cos(\theta_1) - 2 * a * d * Cos(\theta) * Cos(\theta_1) + 2 * a * b * Sin(\theta) * Sin(\beta) - 2 * a * d * Sin(\theta) * Sin(\theta_1) - 2 * b * d * Sin(\beta) * Sin(\theta_1) = 0$$

Dividing with 2,

$$G + a * b * \text{Cos}(\theta) * \text{Cos}(\beta) - b * d * Cos(\beta) * Cos(\theta_1) - a * d * Cos(\theta) * Cos(\theta_1) + a * b * Sin(\theta) * Sin(\beta) - a * d * Sin(\theta) * Sin(\theta_1) - b * d * Sin(\beta) * Sin(\theta_1)$$ →EQ (9)

$$sin\beta = \frac{2\tan\left(\frac{\beta}{2}\right)}{1 + tan^2\left(\frac{\beta}{2}\right)}$$

$$cos\beta = \frac{1 - tan^2\left(\frac{\beta}{2}\right)}{1 + tan^2\left(\frac{\beta}{2}\right)}$$

$$G + a * b * Cos(\theta) * \left[\frac{1 - \tan^2\left(\frac{\beta}{2}\right)}{1 + \tan^2\left(\frac{\beta}{2}\right)}\right] - b * d * \left[\frac{1 - \tan^2\left(\frac{\beta}{2}\right)}{1 + \tan^2\left(\frac{\beta}{2}\right)}\right] * Cos(\theta_1) - a * d * Cos(\theta) * Cos(\theta_1) + a * b * Sin(\theta) * \left[\frac{2\tan\left(\frac{\beta}{2}\right)}{1 + tan^2\left(\frac{\beta}{2}\right)}\right] - a * d * Sin(\theta) * Sin(\theta_1) - b * d * \left[\frac{2\tan\left(\frac{\beta}{2}\right)}{1 + tan^2\left(\frac{\beta}{2}\right)}\right] * Sin(\theta_1) = 0$$

Now multiplying $\left[1 + tan^2\left(\frac{\beta}{2}\right)\right]$ on both sides:

On segregating the terms of $\left[tan^2\left(\frac{\beta}{2}\right)\right]$ and $\left[\tan\left(\frac{\beta}{2}\right)\right]$ we get a quadratic equation as: -

$$[G - a * d * Cos(\theta) * Cos(\theta_1) - a * d * Sin(\theta) * Sin(\theta_1) - a * b * Cos(\theta) + d * b * Cos(\theta_1)]tan^2\left(\frac{\beta}{2}\right) + [2 * a * b * sind(\theta) - 2 * b * d * \sin(\theta_1)] * \tan\left(\frac{\beta}{2}\right) + [G - a * d * Cos(\theta) * Cos(\theta_1) - a * d * Sin(\theta) * Sin(\theta_1) + a * b * Cos(\theta) - b * d * Cos(\theta_1)] = 0$$ →EQ (10)

$D = G - a * d * Sin(\theta) * Sin(\theta_1) + a * Cos(\theta)[d * Cos(\theta_1) - b] + b * d * Cos(\theta_1)$

$E = 2 * a * b * \sin(\theta) - 2 * b * d * Sin(\theta_1)$

$F = G - a * d * Sin(\theta) * Sin(\theta_1) - a * Cos(\theta)[d * Cos(\theta_1) - b] - b * d * Cos(\theta_1)$

$\tan\left(\frac{\beta}{2}\right) = \left[\frac{-E \pm \sqrt{E^2 - 4DF}}{2D}\right]$

$$\beta = 2tan^{-1}\left[\frac{-E \pm \sqrt{E^2 - 4DF}}{2D}\right]$$

VELOCITY ANALYSIS:

Differentiating with respect to time;

$a * \text{Cos}(\theta) + b * Cos(\beta) - c * Cos(\varphi) - d * Cos(\theta_1) = 0$ →Displacement in X-axis

$\frac{d}{dt}(a * Cos(\theta) + b * Cos(\beta) - c * Cos(\varphi) - d) = 0$

$a * \omega_a * \text{Cos}\ (\theta) - b * \omega_b * \sin\ (\beta) + c * \omega_c * \sin\ (\varphi) = 0$→EQ (11)

$\frac{d}{dt}(a * Sin(\theta) + b * Sin(\beta) - c * Sin(\varphi) - d * Sin(\theta_1)) = 0$→Displacement in Y-axis

$a * \omega_a * Cos(\theta) + b * \omega_b * Cos(\beta) - c * \omega_c * Cos(\varphi) = 0$→EQ (12)

Multiply EQ (11) withcos(β) and EQ (12) withsin(β) and add,

$=[-a * \omega_a * Sin(\theta) * Cos(\beta) - b * \omega_b * Sin(\beta) * Cos(\beta) + c * \omega_c * Sin(\varphi) * Cos(\beta)] + [a * \omega_a * \cos\ (\theta) * \sin\ (\beta) + b * \omega_b * \cos\ (\beta) * \sin\ (\beta) - c * \omega_c * \cos(\beta) * \sin\ (\beta)]$

$=aw_a[\ cos\theta sin\beta - sin\theta cos\beta\ ] + bw_b\ [\ cos\beta sin\beta - sin\beta cos\beta\ ] + cw_c\ [\ sin\theta cos\beta - cos\theta sin\beta\ ]$

$= a * w_a[\text{Cos}(\theta) * \text{Sin}(\beta) - Sin(\theta) * Cos(\beta)\ ] + \ c * w_c\ [\ Sin(\theta) * Cos(\beta) - Cos(\theta) * Sin(\beta)\ ] = 0$

$$w_c\ = \frac{a w_a \sin\ (\beta - \theta\ )}{c\ \sin\ (\beta - \theta\ )}$$

where w_c is Angular velocity of the Rocker/ (output link)

Multiplying EQ-11 by $\cos(\varphi)$ and EQ-12 by $\sin\ (\varphi)$ and add,

Simplifying same as mentioned in the above step

$a * w_a[\text{sin}(\varphi) * Cos(\theta) - Sin(\theta) * Cos(\varphi)] + b$

$* w_b\ [\ Sin(\varphi) * Cos(\beta) - \text{Sin}(\beta) * Cos(\varphi)] = 0$

Angular velocity of the Coupler

$$w_b\ = \frac{-\ a w_a \sin\ (\varphi - \theta\ )}{b\ \sin\ (\varphi - \beta\ )}$$

ACCELERATION ANAYSIS:

Differentiating EQ (11) and EQ (12) with time,

$[-\ a * \alpha_a * \text{Sin}(\theta) - a * {w_a}^2 * Cos(\theta)\ ] - [b * \alpha_b * Sin(\beta) - b * {w_b}^2 * Cos(\beta)\ ] +$
$[\ c * \alpha_c\ * Sin(\varphi) + c * {w_c}^2 * Cos(\varphi)\ ] = 0 \rightarrow$ EQ-(13)

$[\ a * \alpha_a * Cos(\theta) - a * {w_a}^2 *\ Sin(\theta)\ ] + [b * \alpha_b\ * Cos(\beta) - b * {w_b}^2 *\ Sin(\beta)\ ] -$
$[\ c * \alpha_c\ * Cos(\varphi) + c * {w_c}^2 *\ Sin(\varphi)\ ] = 0 \rightarrow$ EQ-(14)

Now multiply EQ-(13) by cos(φ) and EQ-(14) by sin (φ) and add

$$a * \propto_a \big(Sin(\varphi) * Cos(\theta) - Cos(\varphi) * Sin(\theta)\big) - a * \omega_a^2\big(Cos(\theta) * Cos(\varphi) + Sin(\theta) * Sin(\varphi)\big) - b * \alpha_b\big(\mathrm{Sin}(\beta) * Cos(\varphi) - Cos(\beta) * Sin(\varphi)\big) - b * \omega_b^2\big(Cos(\beta) * Cos(\varphi) + Sin(\beta) * Sin(\varphi)\big) + c * \omega_c^2 = 0$$

On simplifying;

Angular acceleration of the coupler,

$$\alpha_b = \frac{a \propto_a sin(\varphi - \theta) - a\omega_a^2 cos(\varphi - \theta) - b\omega_b^2 cos(\varphi - \beta) - c\omega_c^2}{b \sin(\beta - \varphi)}$$

Multiply EQ-(13) by cos(β) and EQ-(14) by sin(β),

$$a * \propto_a \big(Sin(\beta) * Cos(\theta) - Cos(\beta) * Sin(\theta)\big) - a * \omega_a^2\big(Cos(\beta) * Cos(\theta) + Sin(\beta) * Sin(\theta)\big) - b * \omega_b^2 + c * \propto_c \big(Sin(\varphi) * Cos(\beta) - Cos(\varphi) * Sin(\beta)\big) + c * \omega_c^2(\cos(\beta)\cos(\varphi) + Sin(\beta)\sin(\varphi)) = 0$$

On simplifying the above equation, we get;

$\alpha_c$is Angular acceleration of the Rocker/ (out-put link),

$$\alpha_c = \frac{a * \propto_a * \mathrm{Sin}(\beta - \theta) - a * \omega_a^2 * \mathrm{Cos}(\beta - \theta) - b * \omega_b^2 + c * \omega_c^2 * \mathrm{Cos}(\beta - \varphi)}{c * \mathrm{Sin}(\beta - \varphi)}$$

We use the same derivations and formulas for the position analysis for the 2nd loop (four-bar mechanism) where the input angle will be only (φ)-which is the angle made by the output link(rocker) to the X-axis.

The following parameters are derived,

$$w_{c1} = \frac{cw_c \sin\ (\beta_1 - \varphi\ )}{c_1 \sin\ (\beta_1 - \varphi\ )}$$

$w_{c1}$is Angular velocity of the Rocker1/ (out-put link)

$$w_{b1} = \frac{-\ cw_c \sin\ (\varphi_1 - \varphi\ )}{b_1 \sin\ (\varphi_1 - \beta_1)}$$

w_{b1} is Angular velocity of the Coupler1

$$\alpha_{b1} = \frac{c \propto_c sin(\varphi_1 - \varphi) - c\omega_c^2 cos(\varphi_1 - \varphi) - b_1\omega_{b1}^2 cos(\varphi_1 - \beta_1) - c_1\omega_{c1}^2}{b_1 \sin\ (\beta - \varphi)}$$

$\alpha_{b1}$is Angular acceleration of the coupler2

$$\alpha_{c1} = \frac{c * \propto_c * \mathrm{Sin}(\beta_1 - \varphi) - c * \omega_c^2 * \mathrm{Cos}(\beta_1 - \varphi) - b_1 * \omega_{b1}^2 + c_1 * \omega_{c1}^2 * \mathrm{Cos}(\beta_1 - \varphi_1)}{c_1 * \mathrm{Sin}\ (\beta_1 - \varphi_1)}$$

α_{c1} is Angular acceleration of the Rocker2/ (out-put link)

CONDITIONS FOR MECHANISM:

The second loop (four-bar mechanism) can be a double crank, double rocker or even a triple rocker.

When we are taking the input lengths from the user for the both the loops

- -In the first loop we check for the Grashof condition and make its arrangements to form a 4-bar mechanism (Crank-Rocker).
- -In the second loop we check for the Grashof condition and make its arrangements to form a 4-bar mechanism (Double-Crank/Double-rocker).
- -If the lengths given by the user does not satisfy Grashof condition and will check for triple rocker.

Once the condition is fixed then we can do the sorting of the links according to the condition we have obtained.

Once the sorting is over then we can we do the position analysis by using the above a formula to find $\beta \ and \ \varphi$(for loop 2) If both the angles are coming out to be real numbers, that means that all the links satisfy the mechanism.

If the angles of $\beta \ and \ \varphi$(for loop 2) are coming to be imaginary means then it means that the all links will not satisfy the mechanism (The links tends to break).

TEST VALUES (SAMPLE PROBLEM):

```
clear all
close all
clc

a=100; % crank
b=260;  % coupler 1
c=180;  % rocker 1
d=200; % fixed link 1

b1=400; % coupler2
c1=240;  % rocker 2
```

```
 d1=150; % fixed link 2
 Wa=pi/10;

 Aa=0
```

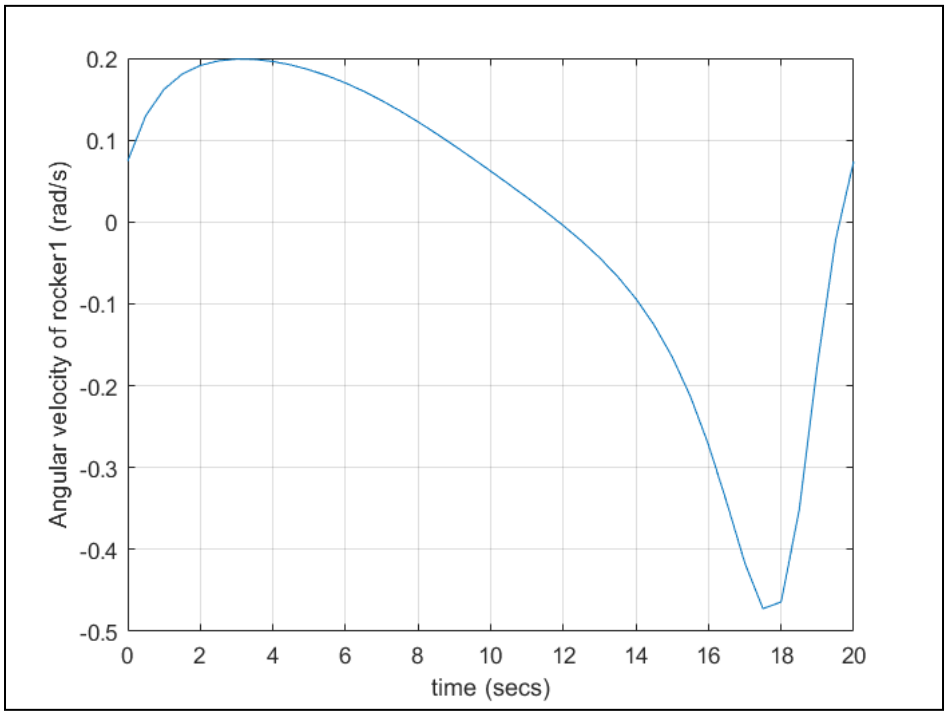
```
Aa = 0
```

```
 initial_angle=45;
 time_of_running=20;
 theta1=20;
 theta2=-20;
 final_angle=initial_angle+((time_of_running*Wa)*180/pi);
 theta=initial_angle:(Wa*180/pi)/2:final_angle;
 time=linspace(0,time_of_running,length(theta));
 k=((a^2-b^2+c^2+d^2)/2);
 A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);
 B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));
 C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);
 si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A))
```

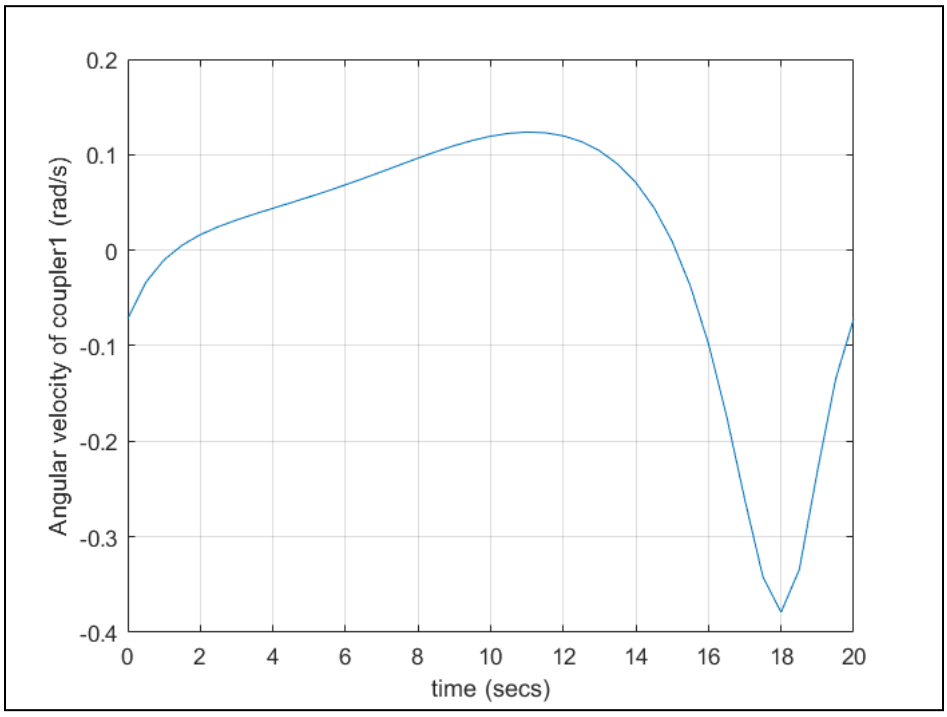
```
si = 1×41

   58.3270   61.3284   65.5525   70.4833   75.8235   81.3915   87.0676 …
```

```
 G=((a^2+b^2-c^2+d^2)/2);
 D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);
 E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);
 F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);
 beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D));
 a1=c;
 k1=((a1^2-b1^2+c1^2+d1^2)/2);
 A1=-a1.*(d1.*cosd(theta2)-c1).*cosd(si)+k1-(c1*d1*cosd(theta2))-
a1*d1.*sind(si).*sind(theta2);
 B1=-(2.*a1.*c1.*sind(si)-2*c1*d1.*sind(theta2));
 C1=-a1*(d1*cosd(theta2)+c1).*cosd(si)+k1+(c1*d1.*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);
 si1=2.*atand((-B1-sqrt((B1.^2)-4.*A1.*C1))./(2*A1));
 G1=((a1^2+b1^2-c1^2+d1^2)/2);
 D1=-a1.*(d1.*cosd(theta2)+b1).*cosd(si)+G1+(d1*cosd(theta2)*b1)-
a1*d1*sind(theta2).*sind(si);
 E1=2*a1*b1.*sind(si)-2*b1*d1.*sind(theta2);
 F1=-(a1.*(d1*cosd(theta2)-b1).*cosd(si))+G1-(b1*d1*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);
```

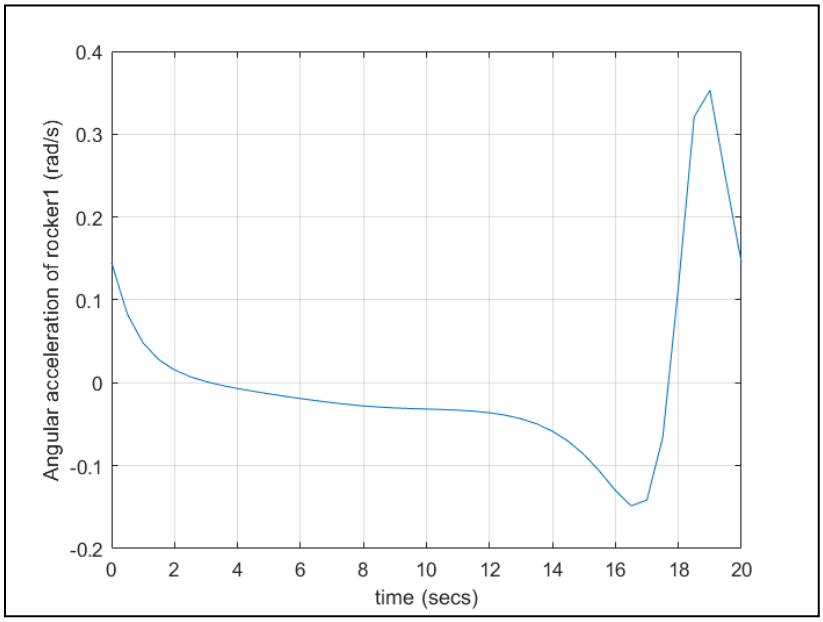
```
 beta1=2.*atand((-E1+sqrt((E1.^2)-4.*D1.*F1))./(2*D1));
 Wc=(a.*Wa.*sind(beta-theta))./(c.*sind(beta-si));
 Wb=(-a*Wa.*sind(si-theta))./(b.*sind(si-beta));
 Ab=((a.*Aa.*sind(si-theta))-(a.*(Wa.^2).*cosd(si-theta))-(b.*(Wb.^2).*cosd(si-beta))-
(c.*(Wc.^2)))./(b.*sind(beta-si));
 Ac=((a.*Aa.*sind(beta-theta))-(a.*(Wa.^2).*cosd(beta-theta))-
(b.*(Wb.^2))+(c.*(Wc.^2).*cosd(beta-si)))./(c.*sind(beta-si));
 Wc1=(a1.*Wc.*sind(beta1-si))./(c1.*sind(beta1-si1));
 Wb1=(-a1*Wc.*sind(si1-si))./(b1.*sind(si1-beta1));
 Ab1=((a1.*Ac.*sind(si1-si))-(a1.*(Wc.^2).*cosd(si1-si))-(b1.*(Wb1.^2).*cosd(si1-
beta1))-(c1.*(Wc1.^2)))./(b1.*sind(beta1-si1));
 Ac1=((a1.*Ac.*sind(beta1-si))-(a1.*(Wc.^2).*cosd(beta1-si))-
(b1.*(Wb1.^2))+(c1.*(Wc1.^2).*cosd(beta1-si1)))./(c1.*sind(beta1-si1));
 plot(time,Wc);
 ylabel('Angular velocity of rocker1 (rad/s)')
 xlabel('time (secs)')
 grid on
```



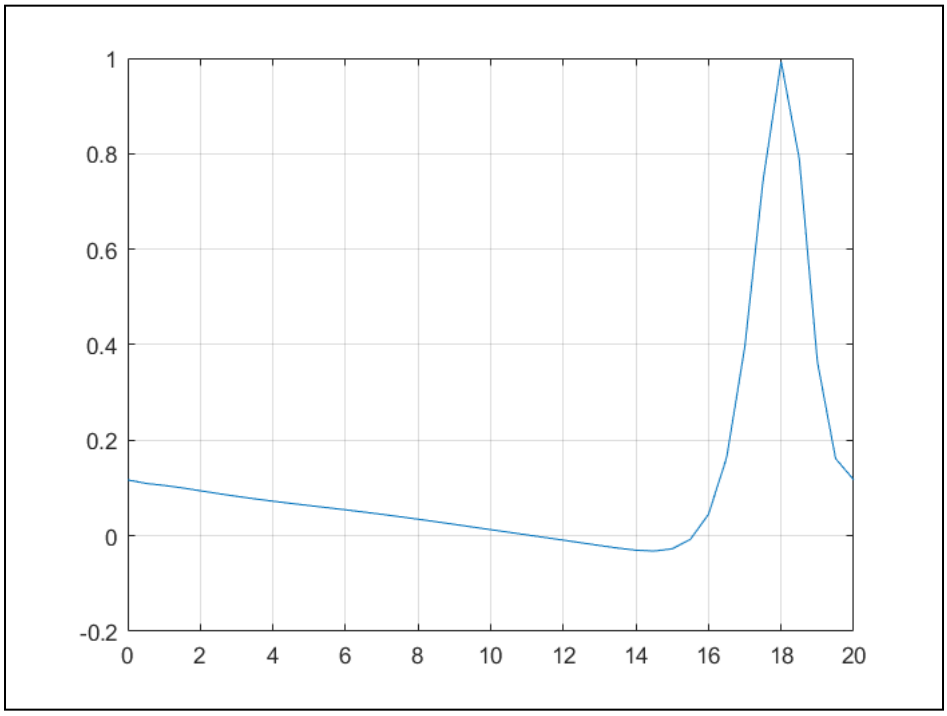

```
 plot(time,Wb);grid on
 ylabel('Angular velocity of coupler1 (rad/s)')
 xlabel('time (secs)')
```



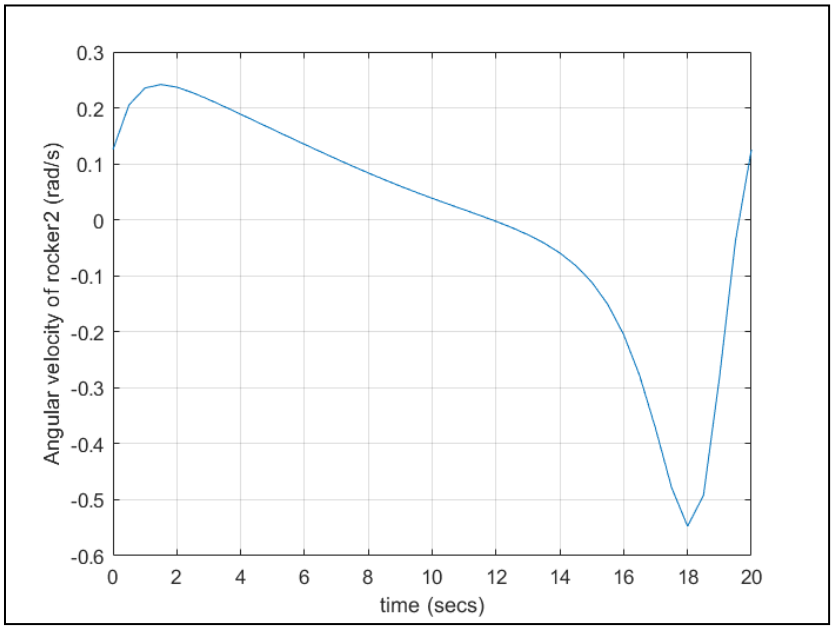

```
plot(time,Ac);grid on
ylabel('Angular acceleration of rocker1 (rad/s)')
xlabel('time (secs)')
```



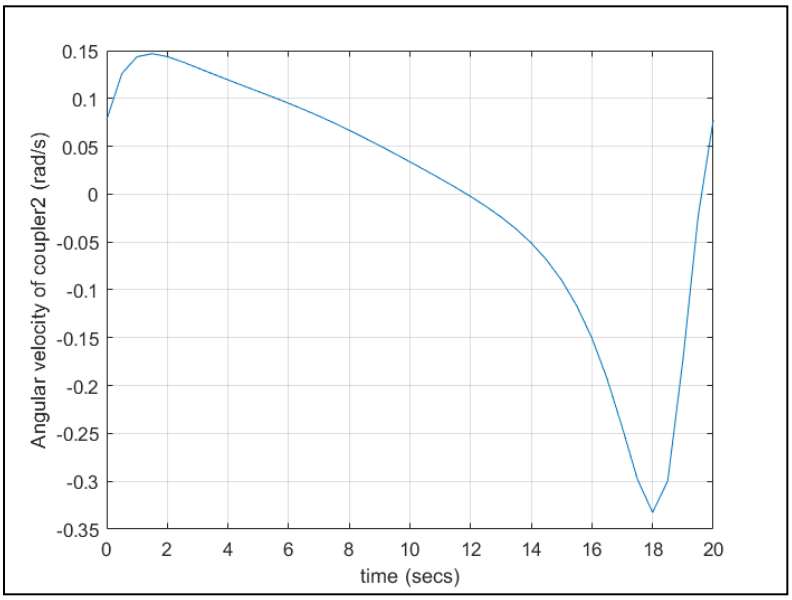
```
plot(time,Ab);grid on
```



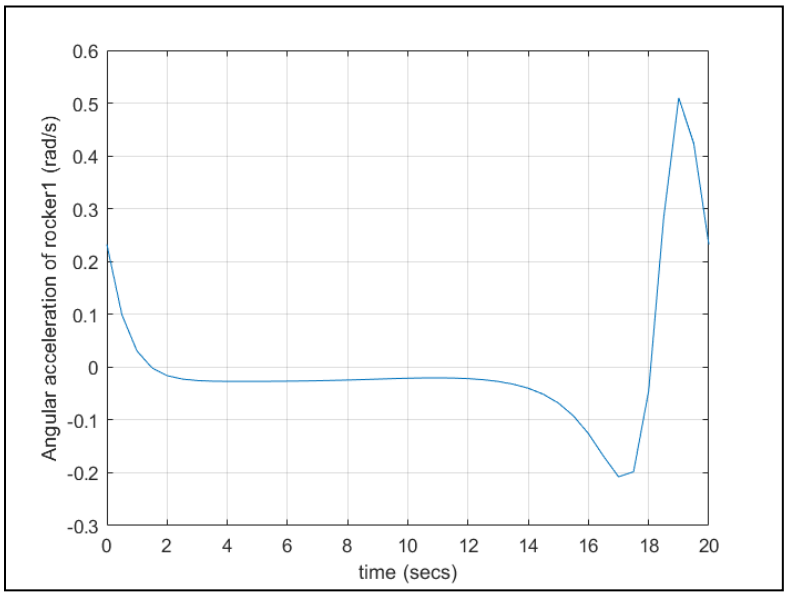

```
ylabel('Angular acceleration of coupler1 (m/s)')
xlabel('time (secs)')
plot(time,Wc1);grid on
ylabel('Angular velocity of rocker2 (rad/s)')
xlabel('time (secs)')
```



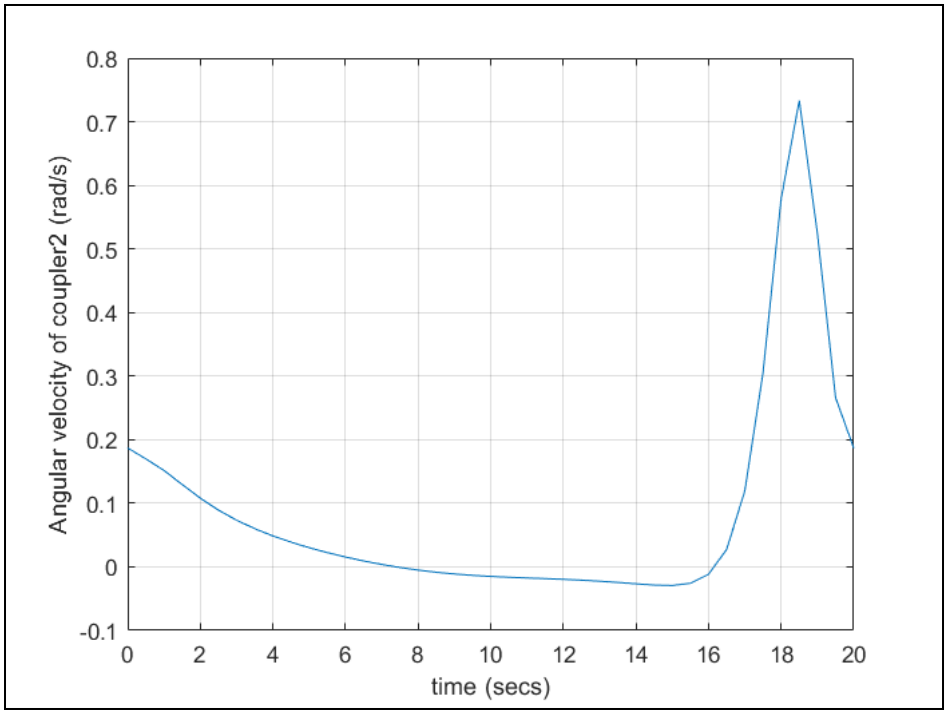
```
plot(time,Wb1);grid on
ylabel('Angular velocity of coupler2 (rad/s)')
xlabel('time (secs)')
```



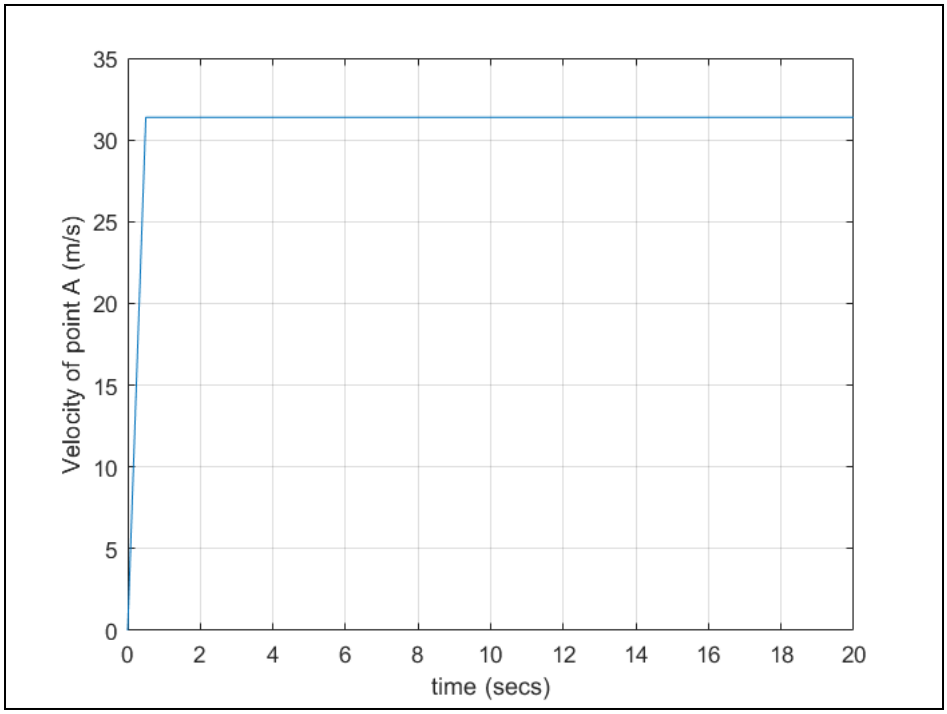

```
plot(time,Ac1);grid on
ylabel('Angular acceleration of rocker2 (rad/s)')
xlabel('time (secs)')
```



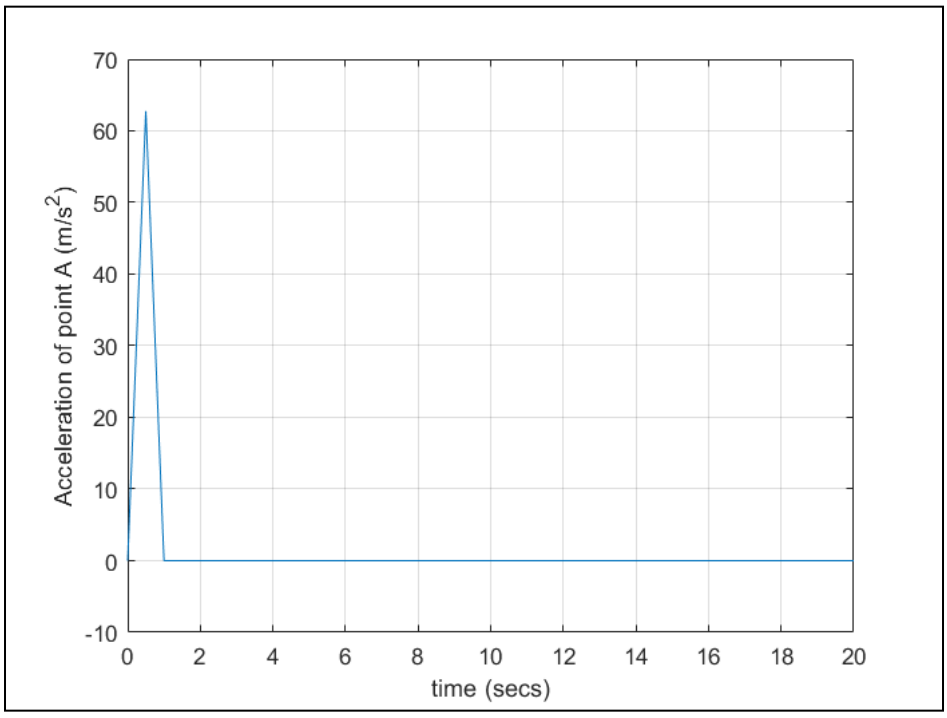

```
plot(time,Ab1);grid on
ylabel('Angular velocity of coupler2 (rad/s)')
xlabel('time (secs)')
```




```
%positions of each point
O=[0;0];
A=[a*cosd(theta);a*sind(theta)];
B=[d*cosd(theta1)+c*cosd(si);d*sind(theta1)+c*sind(si)];
C=[d*cosd(theta1);d*sind(theta1)];
D=[d*cosd(theta1)+c*cosd(si)+b1*cosd(beta1);d*sind(theta1)+c*sind(si)+b1*sind(beta1)]
;
E=[d*cosd(theta1)+d1*cosd(theta2);d*sind(theta1)+d1*sind(theta2)];
A_x=A(1,:);
A_y=A(2,:);
A_vx=diff(A_x)./diff(time);
A_vy=diff(A_y)./diff(time);
A_v=sqrt(A_vx.^2+A_vy.^2);
A_v=[0 A_v];
A_a=diff(A_v)./diff(time);
A_a=[0 A_a];
plot(time,A_v);grid on
ylabel('Velocity of point A (m/s)')
xlabel('time (secs)')
```



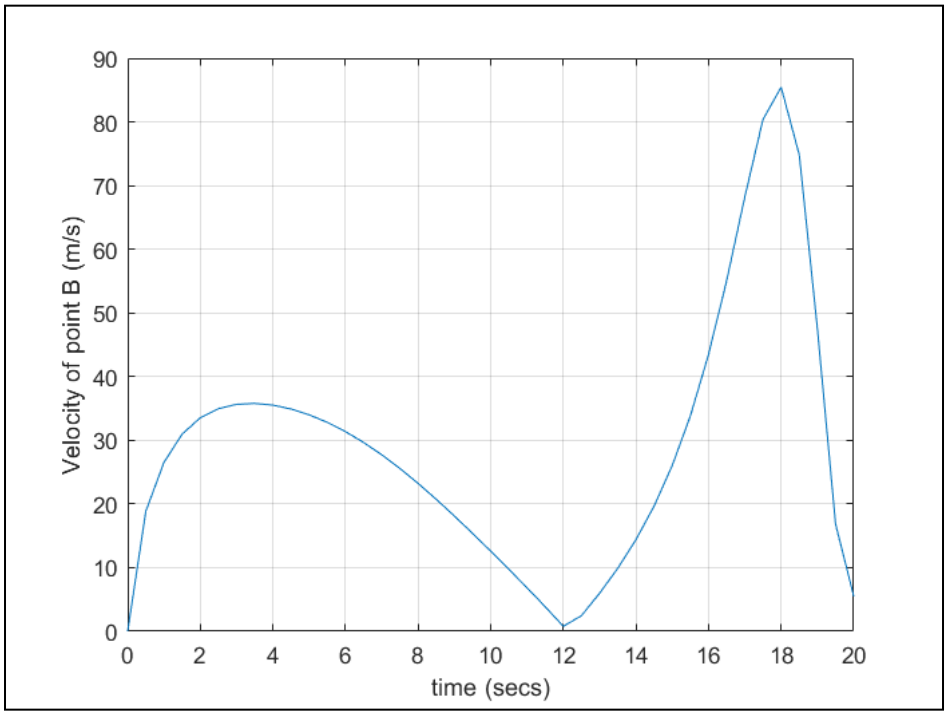

```
plot(time,A_a)
ylabel('Acceleration of point A (m/s^2)')
xlabel('time (secs)')
grid on
```



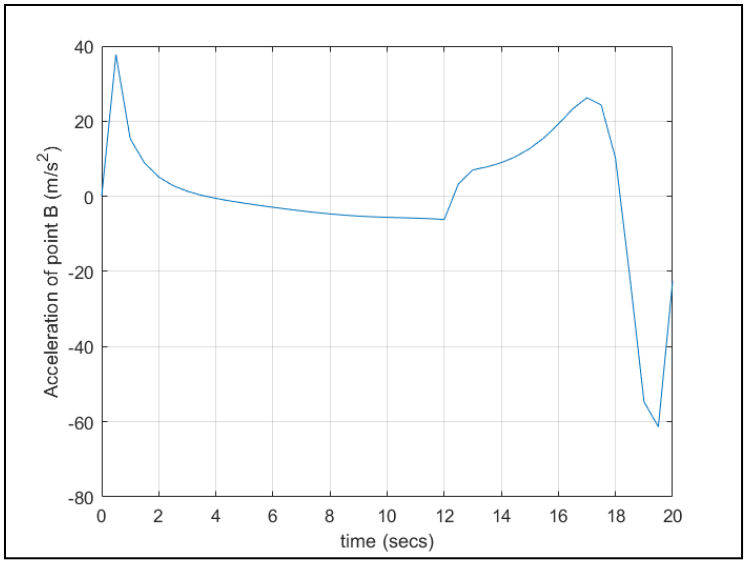
```
B_x=B(1,:);
B_y=B(2,:);
B_vx=diff(B_x)./diff(time);
B_vy=diff(B_y)./diff(time);
B_v=sqrt(B_vx.^2+B_vy.^2);
B_v=[0 B_v]
```

```
B_v = 1×41

         0   18.8562   26.5343   30.9717   33.5416   34.9707   35.6494 ⋯
```

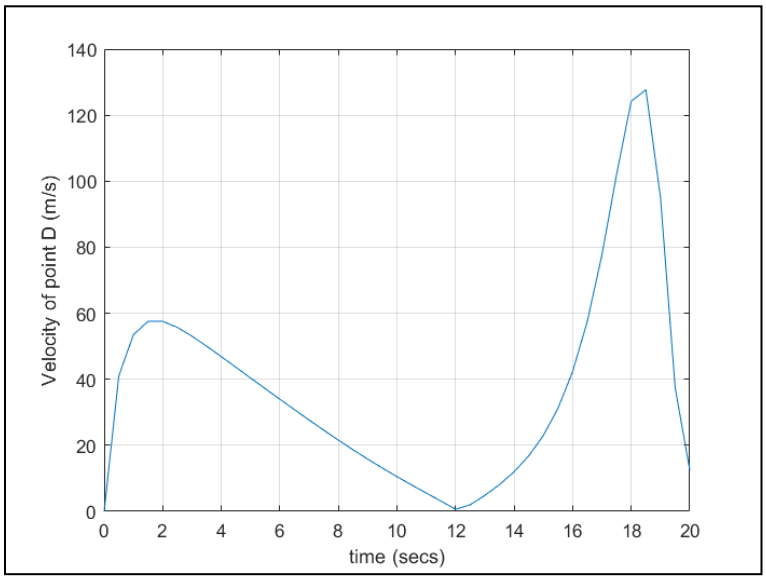
```
B_a=diff(B_v)./diff(time);
B_a=[0 B_a];
plot(time,B_v);grid on
ylabel('Velocity of point B (m/s)')
xlabel('time (secs)')
```



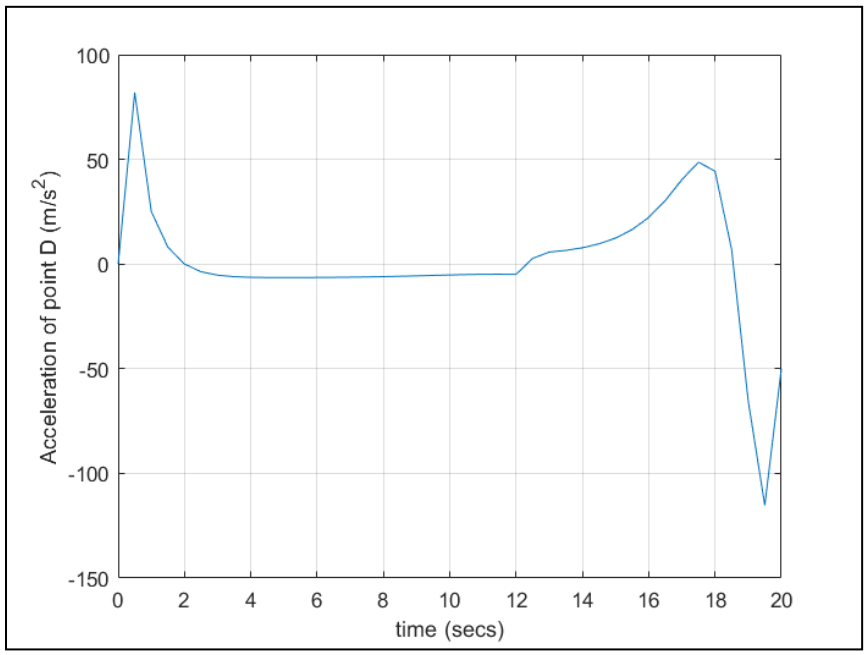

```
plot(time,B_a)
ylabel('Acceleration of point B (m/s^2)')
xlabel('time (secs)')
grid on
```




```
D_x=D(1,:);
D_y=D(2,:);
D_vx=diff(D_x)./diff(time);
D_vy=diff(D_y)./diff(time);
D_v=sqrt(D_vx.^2+D_vy.^2);
D_v=[0 D_v];
D_a=diff(D_v)./diff(time);
D_a=[0 D_a];
plot(time,D_v);grid on
ylabel('Velocity of point D (m/s)')
xlabel('time (secs)')
```



```
plot(time,D_a)
grid on
ylabel('Acceleration of point D (m/s^2)')
xlabel('time (secs)')
```




```
clc;
clear all;
a=100; % crank
b=260;  % coupler 1
c=180;  % rocker 1
d=200; % fixed link 1

b1=400; % coupler2
c1=240;  % rocker 2
d1=150; % fixed link 2

theta1=20;
theta2=-20;

%-----------------------------------------------------------------
%predefined by the user for animation and kinematic analysis

% At what angle u want to find
%user should give at what all links forces are being applied
%magnitude of the force and the angle of force and at what point
```

```
 %it is acting.


 as=20;   Fas=40;     thetaFas=60;
 bs=100;  Fbs=60;      thetaFbs=50;
 cs=100;   Fcs=600;      thetaFcs=45;
 a1s=cs;  Fa1s=Fcs;   thetaFa1s=thetaFcs;
 b1s=300;  Fb1s=100;     thetaFb1s=20;
 c1s=150; Fc1s=30;     thetaFc1s=120;

 %---------------------------------------------------------------
 %here "s" defines the small value of link
 %the external force sholud acts with in the link lenght
 %so checking the conditions
 if as>a
     disp('not possible')
 elseif bs>b
     disp('not possible')
 elseif cs>c
     disp('not possible')
 elseif b1s>b1
     disp('not possible')
 elseif c1s>c1
     disp('not possible')
 else
     disp('possible')
 end
```

```
possible
```

```
 theta=45; %defined by user
 a1=c;
 k=((a^2-b^2+c^2+d^2)/2);
 A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);
 B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));
 C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);
 si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A))
```

```
si = 58.3270
```

```
 G=((a^2+b^2-c^2+d^2)/2);
```

```
 D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);
 E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);
 F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);
 beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D));

 k1=((a1^2-b1^2+c1^2+d1^2)/2);
 A1=-a1.*(d1.*cosd(theta2)-c1).*cosd(si)+k1-(c1*d1*cosd(theta2))-
a1*d1.*sind(si).*sind(theta2);
 B1=-(2.*a1.*c1.*sind(si)-2*c1*d1.*sind(theta2));
 C1=-a1*(d1*cosd(theta2)+c1).*cosd(si)+k1+(c1*d1.*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);
 si1=2.*atand((-B1-sqrt((B1.^2)-4.*A1.*C1))./(2*A1))
```

```
si1 = -22.6868
```

```
 G1=((a1^2+b1^2-c1^2+d1^2)/2);
 D1=-a1.*(d1.*cosd(theta2)+b1).*cosd(si)+G1+(d1*cosd(theta2)*b1)-
a1*d1*sind(theta2).*sind(si);
 E1=2*a1*b1.*sind(si)-2*b1*d1.*sind(theta2);
 F1=-(a1.*(d1*cosd(theta2)-b1).*cosd(si))+G1-(b1*d1*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);
 beta1=2.*atand((-E1+sqrt((E1.^2)-4.*D1.*F1))./(2*D1))
```

```
beta1 = -47.9577
```

```
 syms Fab
 moment_1=cross(as*[cosd(theta) sind(theta) 0],Fas*[cosd(thetaFas) sind(thetaFas)
0])+cross(a*[cosd(theta) sind(theta) 0],Fab*[cosd(beta) sind(beta) 0])==0
```

```
moment_1 =
```

$$\left(0 = 0 \quad 0 = 0 \quad \frac{113829819832041}{549755813888} - \frac{13176607164406675\ \sqrt{2}\ \mathrm{Fab}}{1125899906842624} = 0\right)$$

```
 moment_1 = moment_1(3);
 Fab = double(rhs((isolate(moment_1,Fab))));
 Torque_1 = cross( a*[cosd(theta) sind(theta) 0], Fab*[cosd(beta) sind(beta) 0]);
 fprintf("%f Nm ",Torque_1);
```

```
0.000000 Nm 0.000000 Nm -207.055236 Nm
```

```
 syms Fab
 moment_2=cross(bs*[cosd(beta) sind(beta) 0],Fbs*[cosd(thetaFbs) sind(thetaFbs)
0])+cross(b*[cosd(beta) sind(beta) 0],Fab*[cosd(si) sind(si) 0])==0
```

moment_2 =

$$\left(0=0 \quad 0=0 \quad \frac{800037720246427768635112119054 7\,\mathrm{Fab}}{7922816251426433759354395033 6}+\frac{3309510499610753}{2199023255552}=0\right)$$

```
 moment_2 = moment_2(3);
 Fab = double(rhs((isolate(moment_2,Fab))));
 Torque_2 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(si) sind(si) 0]));
 fprintf("%f Nm ",Torque_2);
```

```
0.000000 Nm 0.000000 Nm -343.550538 Nm
```

```
 syms Fab
 moment_3=cross(cs*[cosd(si) sind(si) 0],Fcs*[cosd(thetaFcs) sind(thetaFcs)
0])+cross([c*cosd(si) c*sind(si) 0],Fab*[cosd(beta) sind(beta) 0])==0 ;
 moment_3 = moment_3(3);
 Fab = double(rhs((isolate(moment_3,Fab))));
 Torque_3 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(beta) sind(beta) 0]));
 fprintf("%f Nm ",Torque_3);
```

```
0.000000 Nm 0.000000 Nm 3274.368838 Nm
```

```
 syms Fab Fcb1
 moment_eq1=cross(bs*[cosd(beta1) sind(beta1) 0],Fb1s*[cosd(thetaFb1s) sind(thetaFb1s)
0])+cross(b1*[cosd(beta1) sind(beta1) 0],Fcb1*[cosd(si1) sind(si1) 0])==0 ;
 moment_eq1 = moment_eq1(3);
 Fcb1 = double(rhs((isolate(moment_eq1,Fcb1)))) ;
 moment_4=cross(Fcb1*[cosd(si1) sind(si1) 0],c*[cosd(si) sind(si)
0])+cross(Fab*[cosd(beta) sind(beta) 0],c*[cosd(si) sind(si) 0])==0 ;
 moment_4 = moment_4(3);
 Fab = double(rhs((isolate(moment_4,Fab))))
```

```
Fab = 138.0483
```

```
 Torque_4 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(beta) sind(beta) 0]))
```

```
Torque_4 = 1×3

10^3 ×

         0         0   -2.2848
```

```
 fprintf("%f Nm ",Torque_4)
```

```
0.000000 Nm 0.000000 Nm -2284.809400 Nm
```

```
 syms Fab Fcb1
```

```
 moment_eq2=cross(cs*[cosd(si1) sind(si1) 0],Fc1s*[cosd(thetaFc1s) sind(thetaFc1s)
0])+cross(c1*[cosd(si) sind(si) 0],Fcb1*[cosd(beta1) sind(beta1) 0])==0
```

moment_eq2 =

$$\left(0=0 \quad 0=0 \quad \frac{499869152287995}{274877906944}-\frac{1460151094249918553799340395175 45\,\mathrm{Fcb}_1}{6338253001141147007483516026 88}=0\right)$$

```
 moment_eq2 = moment_eq2(3);
 Fcb1 = double(rhs((isolate(moment_eq2,Fcb1))));
 moment_5=cross(Fcb1*[cosd(beta1) sind(beta1) 0],c*[cosd(si) sind(si)
0])+cross(Fab*[cosd(beta) sind(beta) 0],c*[cosd(si) sind(si) 0])==0
```

moment_5 =

$$\left(0=0 \quad 0=0 \quad \frac{1107744535725823068329041648429 3\,\mathrm{Fab}}{1584563250285286751870879006 72}+\frac{1499607456863985}{1099511627776}=0\right)$$

```
 moment_5 = moment_5(3);
 Fab = double(rhs((isolate(moment_5,Fab))))
```

```
Fab = -19.5096
```

```
 Torque_5 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(beta) sind(beta) 0]))
```

```
Torque_5 = 1×3

          0          0   322.8989
```

```
 fprintf("%f N-m ",Torque_5)
```

```
0.000000 N-m 0.000000 N-m 322.898882 N-m
```

```
 NET_TORQUE=Torque_1+Torque_2+Torque_3+Torque_4+Torque_5
```

```
NET_TORQUE = 1×3

          0          0   761.8525
```

```
 fprintf("%f N-m ",NET_TORQUE)
```

```
0.000000 N-m 0.000000 N-m 761.852546 N-m
```

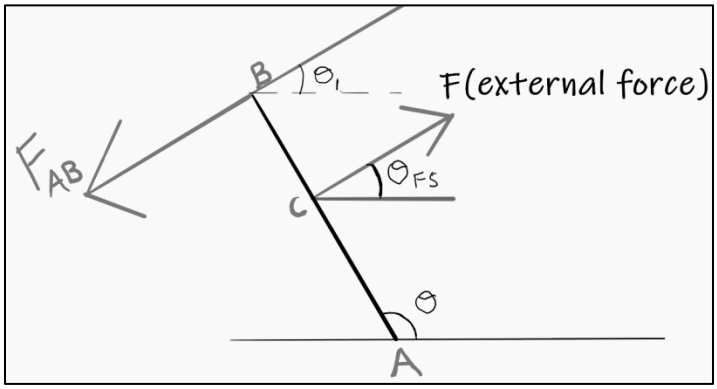
FORCE AND TORQUE ANALYSIS:

FORCE ANALYSIS:

The force which acts on the link must be equal in its respective x and y components

TORQUE ANALYSIS:

The moment applied due to F is equal to moment due to reaction force F_{ab}



$$F = F[Cos(\theta_{FS})i + sin(\theta_{FS})j]$$

$$AC = AC[Cos(\theta)i + sin(\theta)j]$$

$$AB = AB[Cos(\theta)i + sin(\theta)j]$$

$$F_{AB} = F_{AB}[Cos(\theta_1)i + sin(\theta_1)j]$$

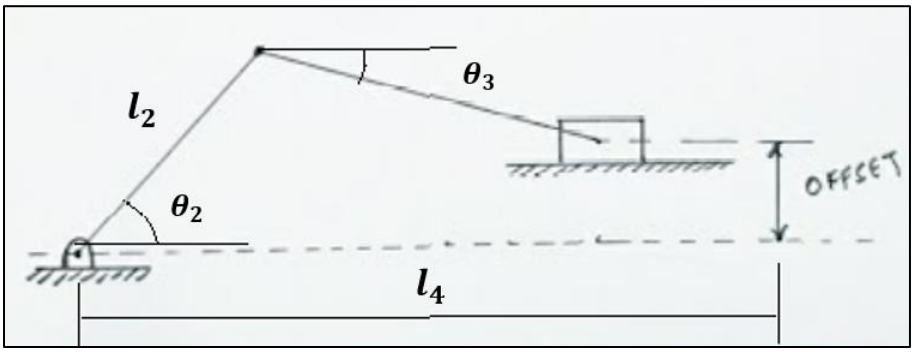
$$\sum \text{Moment} = 0 \; \vec{F} \text{x} \overrightarrow{AC} = \overrightarrow{F_{AB}} \text{x} \overrightarrow{AB}$$

Torque=$\overrightarrow{F_{AB}} \text{x} \overrightarrow{AB}$

TYPE 2:

POSITION ANALYSIS:

Derivation of slider of Crank Mechanism



$c = \text{Rocker of the Crank} - \text{Rocker Mechanism}$

$cr = \text{Conecting rod to the slider and the rocker}$

E→off set

Displacement in X-axis

$$L_4 = c * \text{Cos}(\varphi) + cr * \text{Cos}(-\theta_3)$$

$\text{Cos}(-\theta) = \text{Cos}(\theta)$

$L_4 = c * \text{Cos}(\varphi) + cr * \text{Cos}(\theta_3)$→EQ (1)

Displacement in Y-axis

$E + cr * \text{Sin}(-\theta_3) = c * \text{Sin}(\varphi)$ [E→offset]

$\text{Sin}(-\theta) = -\text{Sin}(\theta)$

$cr * \text{Sin}(\theta_3) = E - c * \text{Sin}(\varphi)$→EQ (2)

Now on re-writing the EQ (2), we get

$$\theta_3 = \mathrm{Sin}^{-1}\left[\frac{E - c * \mathrm{Sin}(\theta_2)}{cr}\right]$$

$\theta_3 =$ angle made by the connecting rod $X -$ axis

VELOCITY ANALYSIS:

Now, differentiation of both EQ (1) and EQ (2) with respect to Time to get the velocity of the links.

$$\frac{d(EQ1)}{dt} = v = -c * \omega_2 * \mathrm{Sin}(\varphi) - cr * \omega_3 * \mathrm{Sin}(\theta_3) \rightarrow \text{EQ (3)}$$

On diff. L4 we are denoting it as "v" = slider/piston liner velocity (It is liner because it moves only in x-axis)

$$\frac{d(EQ2)}{dt} = cr * \omega_3 * \mathrm{Cos}(\theta_3) = 0 - c * \omega_2 * \mathrm{Cos}(\varphi) \rightarrow \text{EQ (4)}$$

$$cr * \omega_3 * \mathrm{Cos}(\theta_3) + c * \omega_2 * \mathrm{Cos}(\varphi) = 0$$

On diff. E, it turns out zero as it remains constant in the complete mechanism

From EQ (4) we get: -

$$\boldsymbol{\omega_3 = \frac{-c * \omega_2 * \mathrm{Cos}(\varphi)}{cr * \mathrm{Cos}(\theta_3)}}$$

ω_3 is ANGULAR VELOCITY OF THE CONNECTING ROD

Now multiply $\mathbf{EQ\ (3)} * \mathrm{Cos}(\theta_3)$ and $\mathbf{EQ\ (4)} * \mathrm{Sin}(\theta_3)$

$$\mathbf{EQ\ (3)} * \mathrm{Cos}(\theta_3)$$

$$v * \mathrm{Cos}(\theta_3) = -c * \omega_2 * \mathrm{Sin}(\varphi) * \mathrm{Cos}(\theta_3) - cr * \omega_3 * \mathrm{Sin}(\theta_3) * \mathrm{Cos}(\theta_3) \rightarrow \text{EQ (5)}$$

Here “v" is the rate of change of distance of the slider

$$\mathbf{EQ}\ (\mathbf{4}) * \mathrm{Sin}(\theta_3)$$

$\mathrm{cr} * \omega_3 * \mathrm{Cos}(\theta_3) * \mathrm{Sin}(\theta_3) + \mathrm{c} * \omega_2 * \mathrm{Cos}(\varphi) * \mathrm{Sin}(\theta_3) = 0$→EQ (6)

ADDING BOTH **EQ (5)** AND **EQ (6)**

$$\mathrm{v} * \ \mathrm{Cos}(\theta_3) = -\mathrm{c} * \omega_2 * \mathrm{Sin}(\varphi) * \mathrm{Cos}(\theta_3) - \mathrm{cr} * \omega_3 * \mathrm{Sin}(\theta_3) * \mathrm{Cos}(\theta_3) + \mathrm{cr} * \omega_3 * \mathrm{Cos}(\theta_3) * \mathrm{Sin}(\theta_3) + \mathrm{c} * \omega_2 * \mathrm{Cos}(\varphi) * \mathrm{Sin}(\theta_3)$$

$\mathrm{v} * \ \mathrm{Cos}(\theta_3) = -\mathrm{c} * \omega_2 * \mathrm{Sin}(\varphi) * \mathrm{Cos}(\theta_3) + \mathrm{c} * \omega_2 * \mathrm{Cos}(\varphi) * \mathrm{Sin}(\theta_3)$

$\mathrm{Sin}(\mathrm{A} - \mathrm{B}) = \sin(\mathrm{A}) * \cos(\mathrm{B}) - \sin(\mathrm{B}) * \cos(\mathrm{A})$ {Where A=θ_3 and B=θ_2}

$v = \frac{c*\omega_2*Sin(\theta_3-\varphi)}{Cos(\theta_3)}$ → LINEAR VELOCITY OF THE SLIDER

ACCELERATION ANALYSIS:

Now, differentiation of both EQ (3) and EQ (4) with respect to Time to get the acceleration of the links.

$\frac{d(EQ3)}{dt} =$

$acc = -c * \alpha_2 * Sin(\varphi) - c * {\omega_2}^2 * Cos(\varphi) - cr * \alpha_3 * Sin(\theta_3) - cr * {\omega_3}^2 * Cos(\theta_3)$→**EQ (7)**

Here "a" rate of change of the velocity of the slider.

$\frac{d(EQ3)}{dt} =$

$0 = cr * \alpha_3 * Cos(\theta_3) - cr * {\omega_3}^2 * Sin(\theta_3) + c * \alpha_2 * Cos(\varphi) - c * {\omega_2}^2 * Sin(\varphi)$→**EQ (8)**

On simplifying the EQ (8) and rewriting it: -

$$\alpha_3 = \frac{cr * {\omega_3}^2 * Sin(\theta_3) - c * \alpha_2 * Cos(\varphi) + c * {\omega_2}^2 * Sin(\varphi)}{cr * Cos(\theta_3)}$$

α_3 =EQUATION FOR COUPLER ACCELERATION

Now multiply **EQ** $(7) * \mathrm{Cos}(\theta_3)$ and **EQ** $(8) * \mathrm{Sin}(\theta_3)$

EQ $(7) * \mathrm{Cos}(\theta_3)$

$\mathrm{a} * \mathrm{Cos}(\theta_3) = -\mathrm{c} * \alpha_2 * \mathrm{Sin}(\varphi) * \mathrm{Cos}(\theta_3) - \mathrm{c} * {\omega_2}^2 * \mathrm{Cos}(\varphi) * \mathrm{Cos}(\theta_3) - \mathrm{cr} * \alpha_3 * \mathrm{Sin}(\theta_3) * \mathrm{Cos}(\theta_3) - \mathrm{cr} * {\omega_3}^2 * \mathrm{Cos}^2(\theta_3)$→**EQ (9)**

EQ $(8) * \mathrm{Sin}(\theta_3)$

$0 = \mathrm{cr} * \alpha_3 * \mathrm{Cos}(\theta_3) * \mathrm{Sin}(\theta_3) - \mathrm{cr} * {\omega_3}^2 * \mathrm{Sin}^2(\theta_3) + \mathrm{c} * \alpha_2 * \mathrm{Cos}(\varphi) * \mathrm{Sin}(\theta_3)$

$-\mathrm{c} * {\omega_2}^2 * \mathrm{Sin}(\varphi) * \mathrm{Sin}(\theta_3)$→**EQ (10)**

NOW, ADDING **EQ (9)** and **EQ (10)**

$\mathrm{acc} * \mathrm{Cos}(\theta_3) = -\mathrm{c} * \alpha_2 * \mathrm{Sin}(\varphi) * \mathrm{Cos}(\theta_3) - \mathrm{c} * {\omega_2}^2 * \mathrm{Cos}(\varphi) * \mathrm{Cos}(\theta_3) - \mathrm{cr} * \alpha_3 * \mathrm{Sin}(\theta_3) * \mathrm{Cos}(\theta_3) - \mathrm{cr} * {\omega_3}^2 * \mathrm{Cos}^2(\theta_3) + \mathrm{cr} * \alpha_3 * \mathrm{Cos}(\theta_3) * \mathrm{Sin}(\theta_3) - \mathrm{cr} * {\omega_3}^2 * \mathrm{Sin}^2(\theta_3) + \mathrm{c} * \alpha_2 * \mathrm{Cos}(\varphi) * \mathrm{Sin}(\theta_3) - \mathrm{c} * {\omega_2}^2 * \mathrm{Sin}(\varphi) * \mathrm{Sin}(\theta_3)$

On simplifying the above expression, we get: -

$$\begin{aligned}\mathrm{acc} * \mathrm{Cos}(\theta_3) = {} & \mathrm{c} * \alpha_2 * \{\mathrm{Cos}(\varphi) * \mathrm{Sin}(\theta_3) - \mathrm{Sin}(\varphi) * \mathrm{Cos}(\theta_3)\} \\ & -\mathrm{c} * {\omega_2}^2 * \{\mathrm{Cos}(\varphi) * \mathrm{Cos}(\theta_3) + \mathrm{Sin}(\varphi) * \mathrm{Sin}(\theta_3)\} \\ & -\mathrm{c} * {\omega_3}^2 \{\mathrm{Sin}^2(\theta_3) + \mathrm{Cos}^2(\theta_3)\}\end{aligned}$$

By using the Trigonometric Expressions and after simplifying we get,

$$\text{acc} * \text{Cos}(\theta_3) = \text{c} * \alpha_2 * \text{Sin}(\theta_3 - \varphi) - \text{c} * {\omega_2}^2 * \text{Cos}(\theta_3 - \varphi) - \text{acc} * {\omega_3}^2$$

$$acc = \frac{c * \alpha_2 * Sin(\theta_3 - \varphi) - c * {\omega_2}^2 * Cos(\theta_3 - \varphi) - cr * {\omega_3}^2}{Cos(\theta_3)}$$

EQUATION OF SLIDER ACCELERATION

Here the output link(rocker) of the four-bar mechanism will act as a slider for the slider crank mechanism for loop2.

CONDITIONS FOR THE MECHANISM:

The second loop is a Slider Crank Mechanism.

When we are taking the input lengths from the user for the both the loops

- -In the first loop we check for the Grashof condition and make its arrangements to form a 4-bar mechanism (Crank-Rocker).
- -In the second loop we check for the Slider Crank stroke Length and then we will find will find the conditions for connecting rod.
- -Once the condition is fixed then we can do the sorting of the links according to the condition we have obtained.

Once the sorting is over then we can we do the position analysis by using the above a formula to find $\theta_3(\text{for loop } 2)$ If angle is coming out to be real numbers, that means that all the links satisfy the mechanism.

If the angles of $\theta_3(\text{for loop } 2)$ are coming to be imaginary means, then it means that the all links will not satisfy the mechanism (The links tends to break).

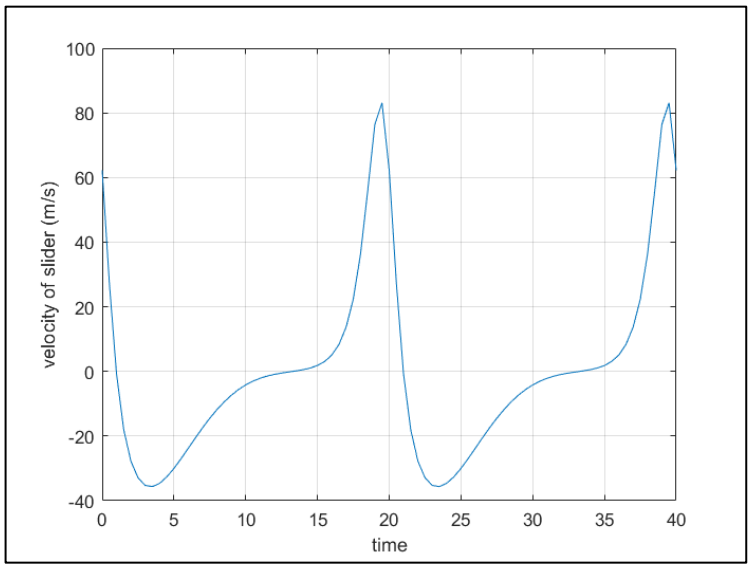
TEST VALUES (SAMPLE PROBLEM):

```
a=100;
b=260;
c=180;
d=200;
cr=500;
e=-60;
theta1=30;
Aa=0
```

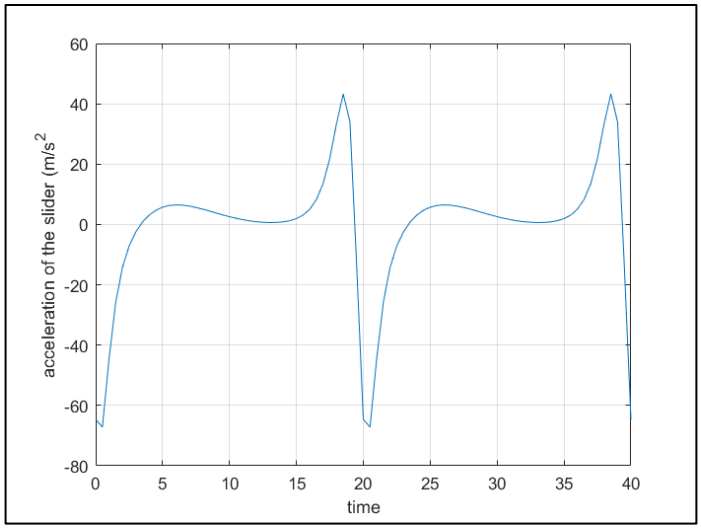
```
Aa = 0
```

```
Wa=pi/10;

initial_angle=30;
time_of_running=40;
final_angle=initial_angle+(time_of_running*Wa*180/pi);


theta=initial_angle:(Wa/2*180/pi):final_angle;
time=linspace(0,time_of_running,length(theta));
k=((a^2-b^2+c^2+d^2)/2);
A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);
B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));
C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);
si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A));

G=((a^2+b^2-c^2+d^2)/2);
D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);
E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);
F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);
beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D));
theta3=asind((e-c.*sind(si))./(cr));

Wc=(a.*Wa.*sind(beta-theta))./(c.*sind(beta-si));
Wb=(-a*Wa.*sind(si-theta))./(b.*sind(si-beta));
Ab=((a.*Aa.*sind(si-theta))-(a.*(Wa.^2).*cosd(si-theta))-(b.*(Wb.^2).*cosd(si-beta))-
(c.*(Wc.^2))./(b.*sind(beta-si));
Ac=((a.*Aa.*sind(beta-theta))-(a.*(Wa.^2).*cosd(beta-theta))-
(b.*(Wb.^2))+(c.*(Wc.^2).*cosd(beta-si)))./(c.*sind(beta-si));
```

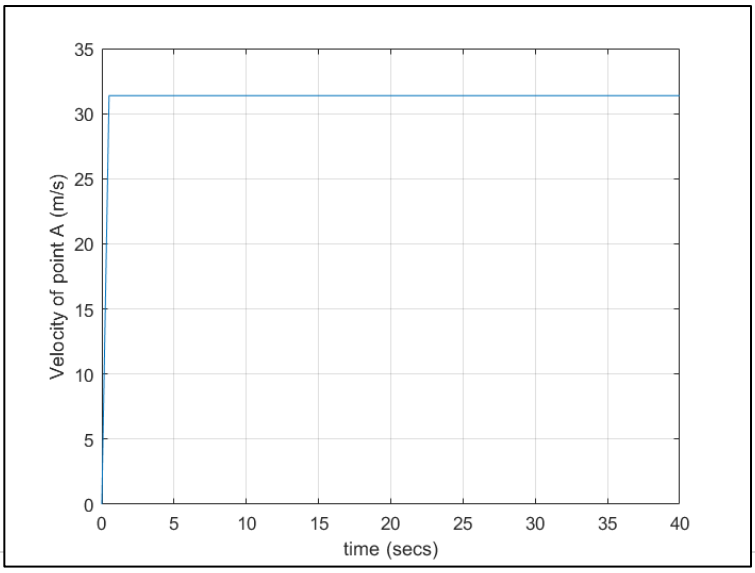
```
 if  imag(beta)>0
     disp('not a mechanism')
     z=1;

 elseif  imag(si)>0
     disp('not a mechanism')
     z=1;

 elseif imag(theta3)>0
      disp('not a mechanism')
      z=1;
 else
     z=0;
 end
 Wcr=-(c*Wc.*cosd(si))./(cr.*cosd(theta3));
 v=((c*Wc.*sind(theta3-si))./(cosd(theta3)));
 plot(time,v)
 grid on
 xlabel('time')
 ylabel('velocity of slider (m/s)')
```



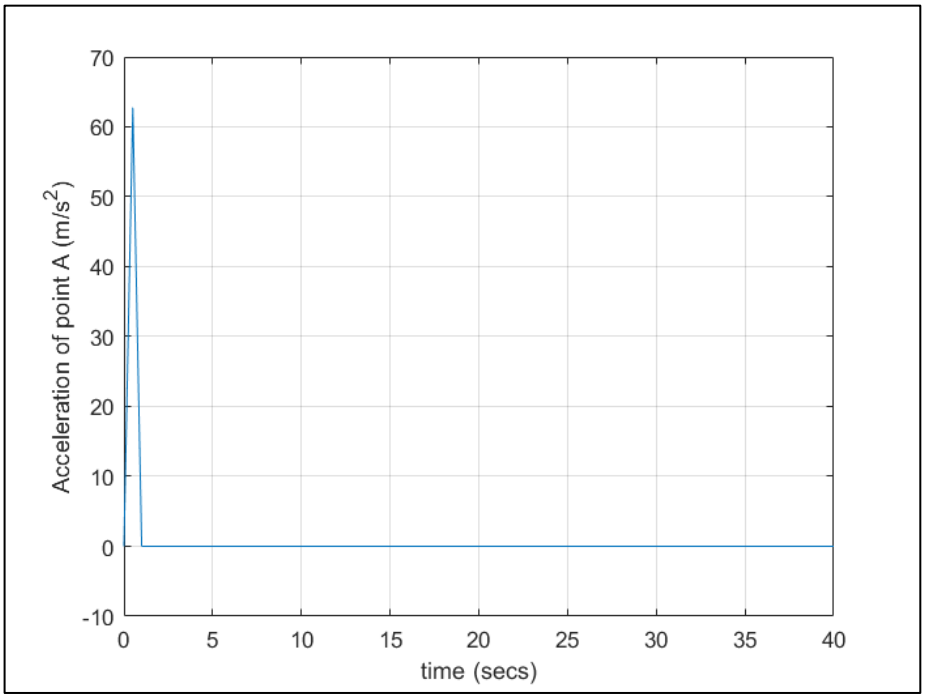

```
 a3=(c*(Wc.^2).*sind(si)+cr.*(Wcr.^2).*sind(theta3)-
c.*Ac.*cos(theta3))./cr.*cosd(theta3);
 a_piston=(c.*Ac.*sind(theta3-si)-c.*(Wc.^2).*cosd(theta3-si)-
cr.*(Wcr.^2))./cosd(theta3);
 plot(time,a_piston)
 grid on
 xlabel('time')
 ylabel('acceleration of the slider (m/s^2')
```



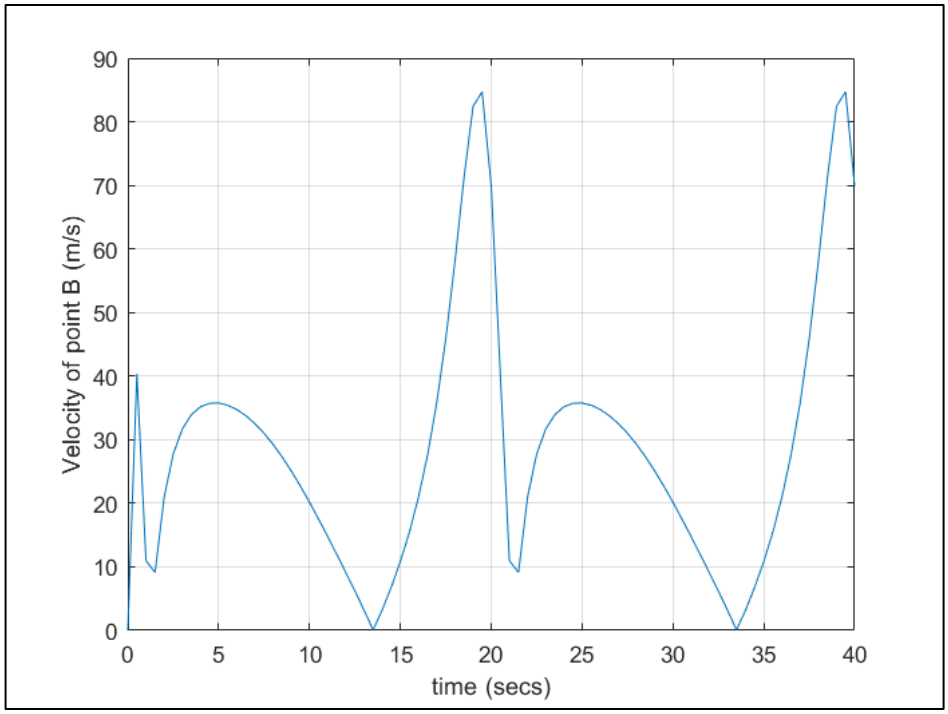

```
%positions of each point
O=[0;0];
A=[a*cosd(theta);a*sind(theta)];
B=[d*cosd(theta1)+c*cosd(si);d*sind(theta1)+c*sind(si)];
A_x=A(1,:);
A_y=A(2,:);
A_vx=diff(A_x)./diff(time);
A_vy=diff(A_y)./diff(time);
A_v=sqrt(A_vx.^2+A_vy.^2);
A_v=[0 A_v];
A_a=diff(A_v)./diff(time);
A_a=[0 A_a];
plot(time,A_v);grid on
ylabel('Velocity of point A (m/s)')
xlabel('time (secs)')
```



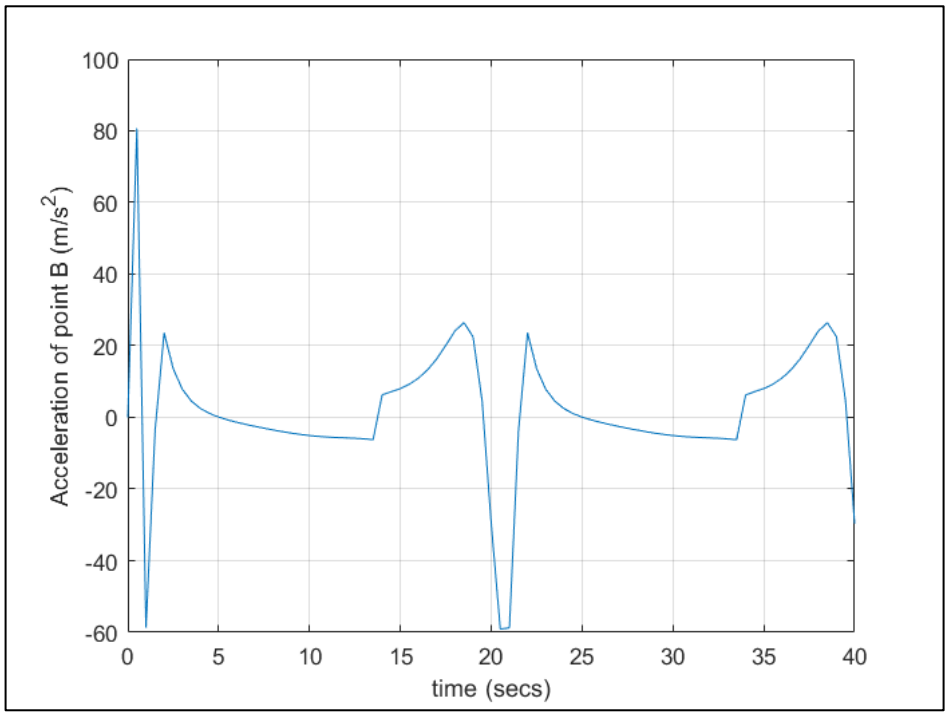
```
plot(time,A_a)
grid on
ylabel('Acceleration of point A (m/s^2)')
xlabel('time (secs)')
```




```
B_x=B(1,:);
B_y=B(2,:);
B_vx=diff(B_x)./diff(time);
B_vy=diff(B_y)./diff(time);
B_v=sqrt(B_vx.^2+B_vy.^2);
B_v=[0 B_v];
B_a=diff(B_v)./diff(time);
B_a=[0 B_a];

plot(time,B_v);grid on
ylabel('Velocity of point B (m/s)')
xlabel('time (secs)')
```




```
plot(time,B_a)
grid on
ylabel('Acceleration of point B (m/s^2)')
xlabel('time (secs)')
```



```
clear all
close all
clc

a=100;
b=260;
c=180;
d=200;
cr=500;
e=-60;
theta1=30;

%-------------------------------------------------------------
%predefined by the user for animation and kinematic analysis

% At what angle u want to find
%user should give at what all links forces are being applied
%magnitude of the force and the angle of force and at what point
%it is acting.


as=20;   Fas=40;     thetaFas=60;  %% crank
bs=100;  Fbs=120;      thetaFbs=10;  %%coupler
cs=100;   Fcs=600;      thetaFcs=45;  %%rocker
crs=300;  Fcrs=100;     thetaFcrs=20;  %%conecting rod
          Fss=30;     thetaFss=120;   %%slider

%-------------------------------------------------------------
%here "s" defines the small value of link
%the external force sholud acts with in the link lenght
%so checking the conditions
if as>a
    disp('not possible')
elseif bs>b
    disp('not possible')
elseif cs>c
    disp('not possible')
elseif crs>cr
    disp('not possible')
else
    disp('possible')
end
```

```
possible
```

```
 theta=45; %defined by user

 k=((a^2-b^2+c^2+d^2)/2);
 A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);
 B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));
 C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);
 si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A));

 G=((a^2+b^2-c^2+d^2)/2);
 D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);
 E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);
 F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);
 beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D));


 theta3=asind((e-c.*sind(si))./(cr));

 syms Fab
 moment_1=cross(as*[cosd(theta) sind(theta) 0],Fas*[cosd(thetaFas) sind(thetaFas)
0])+cross(a*[cosd(theta) sind(theta) 0],Fab*[cosd(beta) sind(beta) 0])==0;
 moment_1 = moment_1(3);
 Fab = double(rhs((isolate(moment_1,Fab))))
```

```
Fab = -31.1974
```

```
 Torque_1 = cross( a*[cosd(theta) sind(theta) 0], Fab*[cosd(beta) sind(beta) 0])
```

```
Torque_1 = 1×3

           0           0 -207.0552
```

```
 fprintf("%f Nm ",Torque_1)
```

```
0.000000 Nm 0.000000 Nm -207.055236 Nm
```

```
 syms Fab
 moment_2=cross([bs*cosd(beta) bs*sind(beta) 0],Fbs*[cosd(thetaFbs) sind(thetaFbs)
0])+cross([b*cosd(beta) b*sind(beta) 0],Fab*[cosd(si) sind(si) 0])==0;
 moment_2 = moment_2(3);
 Fab = double(rhs((isolate(moment_2,Fab))))
```

```
Fab = 90.0201
```

```
Torque_2 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(beta) sind(beta) 0]));
fprintf("%f Nm ",Torque_2)
```

```
0.000000 Nm 0.000000 Nm 597.458477 Nm
```

```
syms Fab
moment_3=cross(cs*[cosd(si) sind(si) 0],Fcs*[cosd(thetaFcs) sind(thetaFcs)
0])+cross([c*cosd(si) c*sind(si) 0],Fab*[cosd(beta) sind(beta) 0])==0;
moment_3 = moment_3(3);
Fab = double(rhs((isolate(moment_3,Fab))))
```

```
Fab = -397.8022
```

```
Torque_3 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(si) sind(si) 0]));
fprintf("%f Nm ",Torque_3)
```

```
0.000000 Nm 0.000000 Nm -15253.475431 Nm
```

```
syms FabF
Fx = Fss + F*cosd(theta3) ==0;
Fbd = double(rhs(vpa(isolate(Fx,F))))
```

```
Fbd = -33.6452
```

```
moment_4=cross(c*[cosd(si) sind(si) 0],Fbd*[cosd(theta3) sind(theta3)
0])+cross(c*[cosd(si) sind(si) 0],Fab*[cosd(beta) sind(beta) 0])==0;
moment_4 = moment_4(3);
Fab = double(rhs((isolate(moment_4,Fab))));
Torque_4 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(beta) sind(beta) 0]))
```

```
Torque_4 = 1×3

           0           0   692.8802
```

```
fprintf("%f Nm ",Torque_4)
```

```
0.000000 Nm 0.000000 Nm 692.880163 Nm
```

```
NET_TORQUE=Torque_1+Torque_2+Torque_3+Torque_4
```

```
NET_TORQUE = 1×3

10^4 ×

           0           0   -1.4170
```

```
fprintf("%f Nm ",NET_TORQUE)
```

```
0.000000 Nm 0.000000 Nm -14170.192027 Nm
```

REFERENCE CONDITIONS:

Grashof's Conditions

Grashof's Law states that for a four-bar linkage system, if the sum of length of shortest and longest of a planar quadrilateral linkage is less than or equal to the sum of the remaining two links , then the shortest link can rotate freely with respect to neighbouring link.

In a four bar chain there are four turning pairs and no sliding pairs.

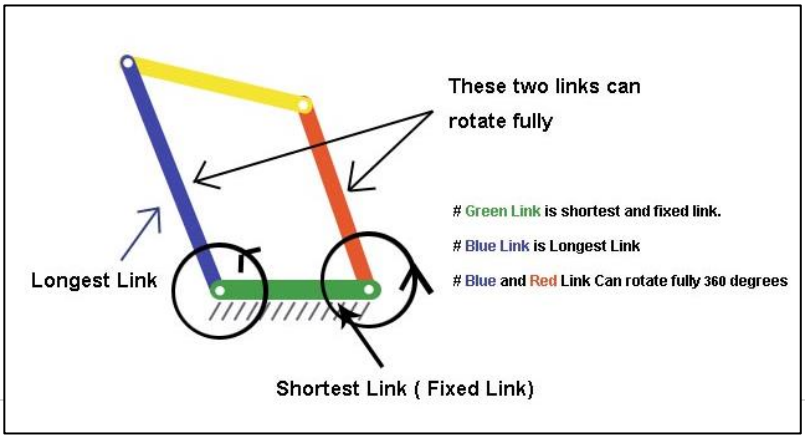
Let denote the smallest link of four bar linkage with S and the longest link by L and the other two links by P and Q.

The necessary condition to satisfy Grashof's Law is :
S + L ≤ P + Q

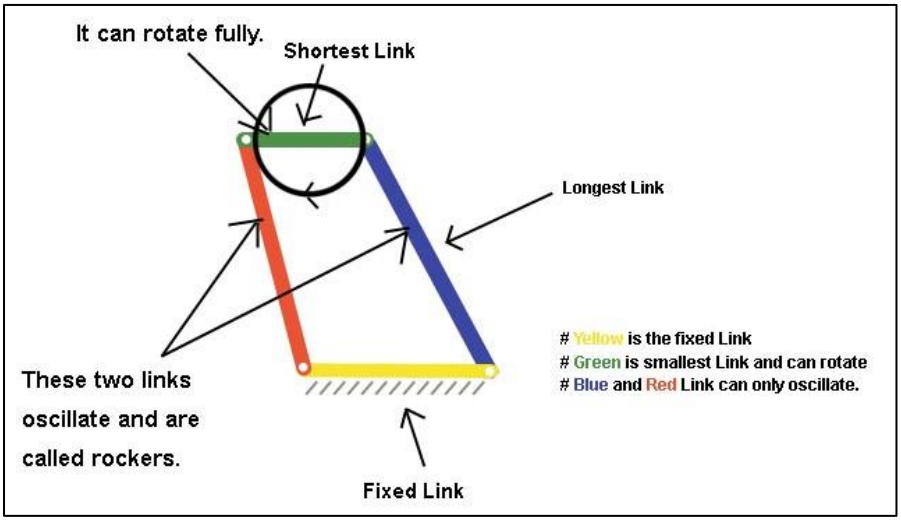
This condition is divided into **two** cases :-
1) S + L < P + Q
2) S + L = P + Q

1) Now let's see the first case i.e **S + L < P + Q**
By fixing different links one at a time this case produces three mechanisms. These mechanisms are: -
i) Double Crank Mechanism
ii) Double Rocker Mechanism
iii) Crank and Rocker Mechanism

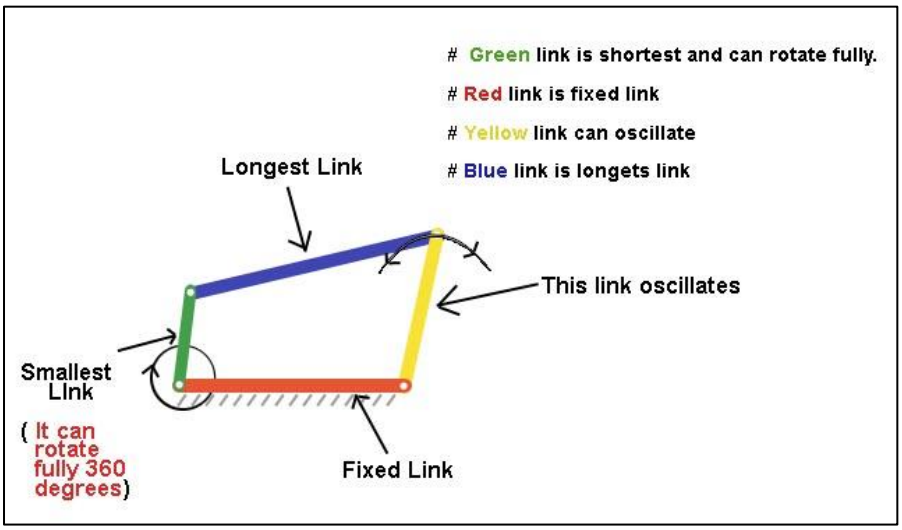
i) Double Crank Mechanism: -



ii) Double Rocker Mechanism: -



iii) Crank and Rocker Mechanism: -

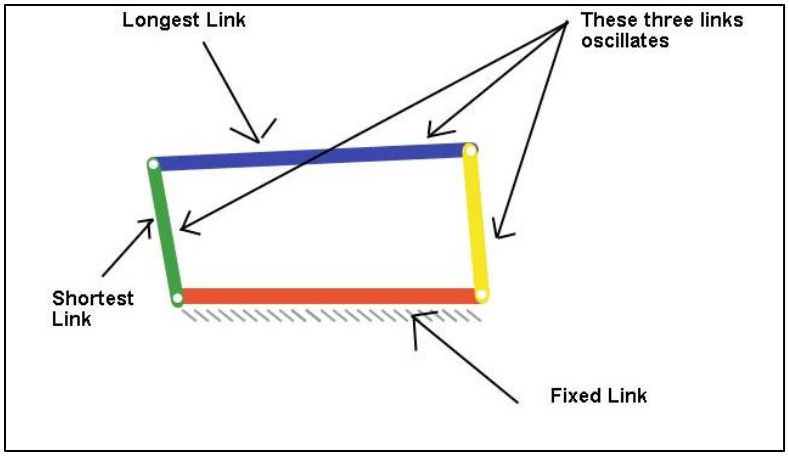


Now let's see the case when the sum of lengths of shortest and longest link is greater than the sum of lengths of remaining two links.

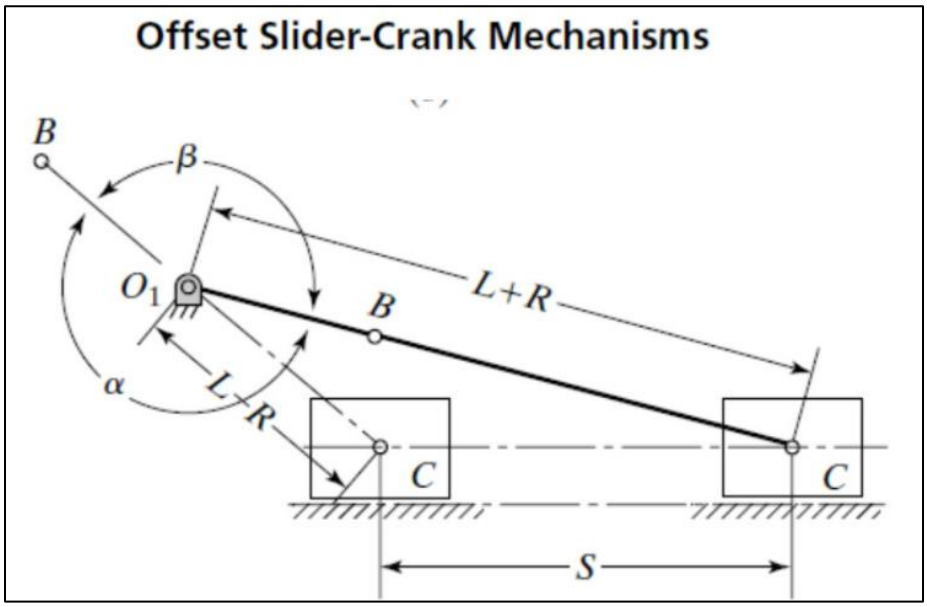
i. e **S + L > P + Q**

In this case, no link can make a complete revolution no matter which of the four link is fixed. So, this case has only one inversion and that is

Triple Rocker Mechanism: - In this mechanism no link will be able to make a complete revolution. All the three links other than the fixed link will oscillate. These three links are called rockers and hence the mechanism is called triple rocker mechanism.



Conditions for Slider Crank: -



Here R=Crank

L=Connecting Rod

S=Stroke Length

E=Off set

$$S = [(L + R)^2 - E^2]^{1/2} - [(L - R)^2 - E^2]^{1/2}$$

$$L - R + S > L + R,$$

VARIABLE STOKE MECHANISM

GUI CODE

```
classdef Variable_Stroke_mech_exported < matlab.apps.AppBase

    % Properties that correspond to app components
    properties (Access = public)
        UIFigure                        matlab.ui.Figure
        TYPE2Button                     matlab.ui.control.Button
        TYPE1Button                     matlab.ui.control.Button
        VARIABLESTROKEMECHANISMLabel    matlab.ui.control.Label
    end
     % Callbacks that handle component events
    methods (Access = private)

        % Button pushed function: TYPE1Button
        function TYPE1ButtonPushed(app, event)
            Variable_Stroke_mechanism_t1
        end
         % Button pushed function: TYPE2Button
        function TYPE2ButtonPushed(app, event)
            Variable_stroke_mechanism_t2
        end
    end
    % Component initialization
    methods (Access = private)

        % Create UIFigure and components
```

```
        function createComponents(app)

            % Create UIFigure and hide until all components are created
            app.UIFigure = uifigure('Visible', 'off');
            app.UIFigure.Position = [100 100 640 480];
            app.UIFigure.Name = 'MATLAB App';

            % Create VARIABLESTROKEMECHANISMLabel
            app.VARIABLESTROKEMECHANISMLabel = uilabel(app.UIFigure);
            app.VARIABLESTROKEMECHANISMLabel.Position = [226 418 190 34];
            app.VARIABLESTROKEMECHANISMLabel.Text = 'VARIABLE STROKE MECHANISM';

            % Create TYPE1Button
            app.TYPE1Button = uibutton(app.UIFigure, 'push');
            app.TYPE1Button.ButtonPushedFcn = createCallbackFcn(app,
@TYPE1ButtonPushed, true);
            app.TYPE1Button.Position = [262 301 135 32];
            app.TYPE1Button.Text = 'TYPE 1';

            % Create TYPE2Button
            app.TYPE2Button = uibutton(app.UIFigure, 'push');
            app.TYPE2Button.ButtonPushedFcn = createCallbackFcn(app,
@TYPE2ButtonPushed, true);
            app.TYPE2Button.Position = [262 236 135 32];
            app.TYPE2Button.Text = 'TYPE 2';

            % Show the figure after all components are created
            app.UIFigure.Visible = 'on';
        end
```

```
    end
     % App creation and deletion
    methods (Access = public)

        % Construct app
        function app = Variable_Stroke_mech_exported

            % Create UIFigure and components
            createComponents(app)

            % Register the app with App Designer
            registerApp(app, app.UIFigure)

            if nargout == 0
                clear app
            end
        end

        % Code that executes before app deletion
        function delete(app)

            % Delete UIFigure when app is deleted
            delete(app.UIFigure)
        end
    end
End
```

VARIABLE STOKE MECHANISM - TYPE 1

GUI CODE

```
classdef Variable_Stroke_mechanism_t1_exported < matlab.apps.AppBase


    % Properties that correspond to app components
    properties (Access = public)
        UIFigure                        matlab.ui.Figure
        thetaFc1sEditField              matlab.ui.control.NumericEditField
        thetaFc1sEditFieldLabel         matlab.ui.control.Label
        thetaFb1sEditField              matlab.ui.control.NumericEditField
        thetaFb1sEditFieldLabel         matlab.ui.control.Label
        thetaFcsEditField               matlab.ui.control.NumericEditField
        thetaFcsEditFieldLabel          matlab.ui.control.Label
        thetaFbsEditField               matlab.ui.control.NumericEditField
        thetaFbsEditFieldLabel          matlab.ui.control.Label
        thetaFasEditField               matlab.ui.control.NumericEditField
        thetaFasEditFieldLabel          matlab.ui.control.Label
        c1sEditField                    matlab.ui.control.NumericEditField
        c1sEditFieldLabel               matlab.ui.control.Label
        b1sEditField                    matlab.ui.control.NumericEditField
        b1sEditFieldLabel               matlab.ui.control.Label
        csEditField                     matlab.ui.control.NumericEditField
        csEditFieldLabel                matlab.ui.control.Label
        bsEditField                     matlab.ui.control.NumericEditField
        bsEditFieldLabel                matlab.ui.control.Label
        asEditField                     matlab.ui.control.NumericEditField
        asEditFieldLabel                matlab.ui.control.Label
```

```
Fc1sEditField                matlab.ui.control.NumericEditField
Fc1sEditFieldLabel           matlab.ui.control.Label
Fb1sEditField                matlab.ui.control.NumericEditField
Fb1sEditFieldLabel           matlab.ui.control.Label
FcsEditField                 matlab.ui.control.NumericEditField
FcsEditFieldLabel            matlab.ui.control.Label
FbsEditField                 matlab.ui.control.NumericEditField
FbsEditFieldLabel            matlab.ui.control.Label
FasEditField                 matlab.ui.control.NumericEditField
FasEditFieldLabel            matlab.ui.control.Label
TYPEDropDown_13              matlab.ui.control.DropDown
TYPEDropDown_13Label         matlab.ui.control.Label
TYPEDropDown_12              matlab.ui.control.DropDown
TYPEDropDown_12Label         matlab.ui.control.Label
TYPEDropDown_11              matlab.ui.control.DropDown
TYPEDropDown_11Label         matlab.ui.control.Label
TYPEDropDown_10              matlab.ui.control.DropDown
TYPEDropDown_10Label         matlab.ui.control.Label
TYPEDropDown_9               matlab.ui.control.DropDown
TYPEDropDown_9Label          matlab.ui.control.Label
TYPEDropDown_8               matlab.ui.control.DropDown
TYPEDropDown_8Label          matlab.ui.control.Label
NetaccelerationDropDown      matlab.ui.control.DropDown
NetaccelerationDropDownLabel matlab.ui.control.Label
NetvelocityDropDown          matlab.ui.control.DropDown
NetvelocityDropDownLabel     matlab.ui.control.Label
AngularaccelarationDropDown  matlab.ui.control.DropDown
AngularaccelarationDropDownLabel  matlab.ui.control.Label
```

```
        AngularvelocityDropDown       matlab.ui.control.DropDown
        AngularvelocityDropDownLabel  matlab.ui.control.Label
        PLOTSLabel                    matlab.ui.control.Label
        Initialanglemadebycrank1withhorizontaldegreesEditField
matlab.ui.control.NumericEditField
        Initialanglemadebycrank1withhorizontaldegreesEditFieldLabel
matlab.ui.control.Label
        AnimationCheckBox             matlab.ui.control.CheckBox
        InclinationoffixedlinkdegreesEditField  matlab.ui.control.NumericEditField
        InclinationoffixedlinkdegreesEditFieldLabel  matlab.ui.control.Label
        LENGTHmEditField_7            matlab.ui.control.NumericEditField
        LENGTHmEditField_7Label       matlab.ui.control.Label
        LENGTHmEditField_6            matlab.ui.control.NumericEditField
        LENGTHmEditField_6Label       matlab.ui.control.Label
        LENGTHmEditField_5            matlab.ui.control.NumericEditField
        LENGTHmEditField_5Label       matlab.ui.control.Label
        L7Label                       matlab.ui.control.Label
        L6Label_2                     matlab.ui.control.Label
        L5Label_2                     matlab.ui.control.Label
        AngularvelocityofDrivercrankradsEditField
matlab.ui.control.NumericEditField
        AngularvelocityofDrivercrankradsEditFieldLabel  matlab.ui.control.Label
        CLOSEButton                   matlab.ui.control.Button
        RESETButton                   matlab.ui.control.Button
        SAVEASButton                  matlab.ui.control.Button
        CALCULATEButton               matlab.ui.control.Button
        StaticforceanalysisCheckBox   matlab.ui.control.CheckBox
        VelocityandaccelerationanalysisCheckBox  matlab.ui.control.CheckBox
        InclinationoffixedlinkdegreesEditField  matlab.ui.control.NumericEditField
        InclinationoffixedlinkdegreesEditFieldLabel  matlab.ui.control.Label
```

```
        ANGLEVARIATIONLabel           matlab.ui.control.Label
        TimestepsecsEditField         matlab.ui.control.NumericEditField
        TimestepsecsEditFieldLabel    matlab.ui.control.Label
        DurationofanimationsecsEditField  matlab.ui.control.NumericEditField
        DurationofanimationsecsEditFieldLabel  matlab.ui.control.Label
        TIMEINTERVALLabel             matlab.ui.control.Label
        ANALYSISLabel                 matlab.ui.control.Label
        LENGTHmEditField_4            matlab.ui.control.NumericEditField
        LENGTHmEditField_4Label       matlab.ui.control.Label
        L4Label_2                     matlab.ui.control.Label
        LENGTHmEditField_3            matlab.ui.control.NumericEditField
        LENGTHmEditField_3Label       matlab.ui.control.Label
        L3Label_2                     matlab.ui.control.Label
        LENGTHmEditField_2            matlab.ui.control.NumericEditField
        LENGTHmEditField_2Label       matlab.ui.control.Label
        L2Label_2                     matlab.ui.control.Label
        L1Label_2                     matlab.ui.control.Label
        LENGTHmmEditField             matlab.ui.control.NumericEditField
        LENGTHmmEditFieldLabel        matlab.ui.control.Label
        INPUTLabel                    matlab.ui.control.Label
    end

methods (Access = public)
    function Animation_t1(app)
            l1 = app.LENGTHmmEditField.Value;
            l2 = app.LENGTHmEditField_2.Value;
            l3= app.LENGTHmEditField_3.Value;
            l4= app.LENGTHmEditField_4.Value;
```

```
l5 = app.LENGTHmEditField_5.Value;
l6 = app.LENGTHmEditField_6.Value;
l7 = app.LENGTHmEditField_7.Value;

B=[l3;l5;l6;l7];
Q=sort(B);
A = [l1;l2;l3;l4];
P=sort(A);
if(P(1)+P(4)<P(2)+P(3))
   a=P(1);
   b=P(4);
   c=P(2);
   d=P(3);
   if(Q(1)+Q(4)<Q(2)+Q(3))
     if(c==Q(4))
       a1=Q(4);
       b1=Q(2);
       c1=Q(3);
       d1=Q(1);
     else
        b1=Q(1);
        c1=Q(4);
        if(P(2)==Q(2))
            a1=Q(2);
            d1 = Q(3);
        else d1 = Q(2);
             a1 = Q(3);
        end
```

```
                end
                check_3=1;
            elseif(Q(1)+Q(4)>Q(2)+Q(3))
                if(c==Q(1))
                    b1=Q(4)
                    c1=Q(2)
                    d1=Q(2)
                    a1=Q(1)
                    check_3=1;
                else
                  d1=Q(1);
                  a1=P(2);
                  b1=Q(4);
                  c1=Q(3);
                  check_3=1;
                end
            else check_3 = 0;
            end
        else check_3 =0;
        end
        t = app.DurationofanimationsecsEditField.Value;
        delt =app.TimestepsecsEditField.Value;
        initial_angle =
app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value;
        Wa = app.AngularvelocityofDrivercrankradsEditField.Value;
        theta1 = app.Inclinationoffixedlink1degreesEditField.Value;
        theta2 = app.Inclinationoffixedlink2degreesEditField.Value;

        A_a=0;
```

```
            final_angle = (((Wa*t*180/pi)+initial_angle));


          for theta=initial_angle:delt:final_angle


            k=((a^2-b^2+c^2+d^2)/2);

            A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);

            B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));

            C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

            si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A));


            G=((a^2+b^2-c^2+d^2)/2);

            D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);

            E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);

            F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

            beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D));


            k1=((a1^2-b1^2+c1^2+d1^2)/2);

            A1=-a1.*(d1.*cosd(theta2)-c1).*cosd(si)+k1-(c1*d1*cosd(theta2))-
a1*d1.*sind(si).*sind(theta2);

            B1=-(2.*a1.*c1.*sind(si)-2*c1*d1.*sind(theta2));

            C1=-a1*(d1*cosd(theta2)+c1).*cosd(si)+k1+(c1*d1.*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);

            si1=2.*atand((-B1-sqrt((B1.^2)-4.*A1.*C1))./(2*A1));


            G1=((a1^2+b1^2-c1^2+d1^2)/2);

            D1=-a1.*(d1.*cosd(theta2)+b1).*cosd(si)+G1+(d1*cosd(theta2)*b1)-
a1*d1*sind(theta2).*sind(si);
```

```
            E1=2*a1*b1.*sind(si)-2*b1*d1.*sind(theta2);

            F1=-(a1.*(d1*cosd(theta2)-b1).*cosd(si))+G1-(b1*d1*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);

            beta1=2.*atand((-E1+sqrt((E1.^2)-4.*D1.*F1))./(2*D1));


             plot([0 a*cosd(theta)], [0 a*sind(theta)],'ko-','LineWidth',2);hold
on;

             plot([d*cosd(theta1) d*cosd(theta1)+c*cosd(si)], [d*sind(theta1)
d*sind(theta1)+c*sind(si)], 'bo-','LineWidth',2); hold on;

             plot([0 d*cosd(theta1)], [0 d*sind(theta1)], 'mo-','LineWidth',2);
hold on;

             plot([a*cosd(theta) a*cosd(theta)+b*cosd(beta)], [a*sind(theta)
a*sind(theta)+b*sind(beta)], 'ro-','LineWidth',2);hold on;

             plot([d*cosd(theta1) d*cosd(theta1)+d1*cosd(theta2)], [d*sind(theta1)
d*sind(theta1)+d1*sind(theta2)], 'go-','LineWidth',2);hold on;

             plot([d*cosd(theta1)+d1*cosd(theta2)
d*cosd(theta1)+d1*cosd(theta2)+c1*cosd(si1)],[d*sind(theta1)+d1*sind(theta2)
d*sind(theta1)+d1*sind(theta2)+c1*sind(si1)], 'co-','LineWidth',2);hold on;

             plot([d*cosd(theta1)+c*cosd(si)
d*cosd(theta1)+c*cosd(si)+b1*cosd(beta1)], [d*sind(theta1)+c*sind(si)
d*sind(theta1)+c*sind(si)+b1*sind(beta1)], 'yo-','LineWidth',2);hold off;

             grid on

             axis([-200 600 -200 600]);

             pbaspect([1 1 1]);

             pause(0.01);

             drawnow

          end

         end

         function Velocity_accleration_A(app)

             l1 = app.LENGTHmmEditField.Value;

             l2 = app.LENGTHmEditField_2.Value;

             l3= app.LENGTHmEditField_3.Value;

             l4= app.LENGTHmEditField_4.Value;
```

```
l5 = app.LENGTHmEditField_5.Value;
l6 = app.LENGTHmEditField_6.Value;
l7 = app.LENGTHmEditField_7.Value;

B=[l3;l5;l6;l7];
Q=sort(B);

A = [l1;l2;l3;l4];
P=sort(A);

if(P(1)+P(4)<P(2)+P(3))
   a=P(1);
   b=P(4);
   c=P(2);
   d=P(3);
   if(Q(1)+Q(4)<Q(2)+Q(3))
     if(c==Q(4))
       a1=Q(4);
       b1=Q(2);
       c1=Q(3);
       d1=Q(1);
     else
        b1=Q(1);
        c1=Q(4);
        if(P(2)==Q(2))
            a1=Q(2);
            d1 = Q(3);
```

```
            else d1 = Q(2);
                 a1 = Q(3);
            end
        end
        check_3=1;
    elseif(Q(1)+Q(4)>Q(2)+Q(3))
        if(c==Q(1))
                b1=Q(4)
                c1=Q(2)
                d1=Q(2)
                a1=Q(1)
                check_3=1;
            else
              d1=Q(1);
              a1=P(2);
              b1=Q(4);
              c1=Q(3);
              check_3=1;
        end
    else check_3 = 0;

    end
else check_3 =0;

end

time_of_running = app.DurationofanimationsecsEditField.Value;
delt =app.TimestepsecsEditField.Value;
```

```
            Wa = app.AngularvelocityofDrivercrankradsEditField.Value;

            theta1 = app.Inclinationoffixedlink1degreesEditField.Value;

            theta2 = app.Inclinationoffixedlink2degreesEditField.Value;

            initial_angle =
app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value;

            Aa=0;

            final_angle=initial_angle+((time_of_running*Wa)*180/pi);

            theta=initial_angle:(Wa*180/pi)/2:final_angle;

            time=linspace(0,time_of_running,length(theta));


            k=((a^2-b^2+c^2+d^2)/2);

            A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);

            B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));

            C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

            si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A));


            G=((a^2+b^2-c^2+d^2)/2);

            D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);

            E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);

            F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

            beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D));


            a1=c;

            k1=((a1^2-b1^2+c1^2+d1^2)/2);

            A1=-a1.*(d1.*cosd(theta2)-c1).*cosd(si)+k1-(c1*d1*cosd(theta2))-
a1*d1.*sind(si).*sind(theta2);

            B1=-(2.*a1.*c1.*sind(si)-2*c1*d1.*sind(theta2));
```

```
            C1=-a1*(d1*cosd(theta2)+c1).*cosd(si)+k1+(c1*d1.*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);

            si1=2.*atand((-B1-sqrt((B1.^2)-4.*A1.*C1))./(2*A1));



            G1=((a1^2+b1^2-c1^2+d1^2)/2);

            D1=-a1.*(d1.*cosd(theta2)+b1).*cosd(si)+G1+(d1*cosd(theta2)*b1)-
a1*d1*sind(theta2).*sind(si);

            E1=2*a1*b1.*sind(si)-2*b1*d1.*sind(theta2);

            F1=-(a1.*(d1*cosd(theta2)-b1).*cosd(si))+G1-(b1*d1*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);

            beta1=2.*atand((-E1+sqrt((E1.^2)-4.*D1.*F1))./(2*D1));



            Wc=(a.*Wa.*sind(beta-theta))./(c.*sind(beta-si));

            Wb=(-a*Wa.*sind(si-theta))./(b.*sind(si-beta));

            Ab=((a.*Aa.*sind(si-theta))-(a.*(Wa.^2).*cosd(si-theta))-
(b.*(Wb.^2).*cosd(si-beta))-(c.*(Wc.^2))).*(b.*sind(beta-si));

            Ac=((a.*Aa.*sind(beta-theta))-(a.*(Wa.^2).*cosd(beta-theta))-
(b.*(Wb.^2))+(c.*(Wc.^2).*cosd(beta-si))).*(c.*sind(beta-si));

            Wc1=(a1.*Wc.*sind(beta1-si))./(c1.*sind(beta1-si1));

            Wb1=(-a1*Wc.*sind(si1-si))./(b1.*sind(si1-beta1));

            Ab1=((a1.*Ac.*sind(si1-si))-(a1.*(Wc.^2).*cosd(si1-si))-
(b1.*(Wb1.^2).*cosd(si1-beta1))-(c1.*(Wc1.^2))).*(b1.*sind(beta1-si1));

            Ac1=((a1.*Ac.*sind(beta1-si))-(a1.*(Wc.^2).*cosd(beta1-si))-
(b1.*(Wb1.^2))+(c1.*(Wc1.^2).*cosd(beta1-si1))).*(c1.*sind(beta1-si1));



            %positions of each point

            O=[0;0];

            A=[a*cosd(theta);a*sind(theta)];

            B=[d*cosd(theta1)+c*cosd(si);d*sind(theta1)+c*sind(si)];

            C=[d*cosd(theta1);d*sind(theta1)];
```

```
D=[d*cosd(theta1)+c*cosd(si)+b1*cosd(beta1);d*sind(theta1)+c*sind(si)+b1*sind(beta1
)];
            E=[d*cosd(theta1)+d1*cosd(theta2);d*sind(theta1)+d1*sind(theta2)];


            A_x=A(1,:);
            A_y=A(2,:);


            A_vx=diff(A_x)./diff(time);
            A_vy=diff(A_y)./diff(time);


            A_v=sqrt(A_vx.^2+A_vy.^2);
            A_v=[0 A_v];


            A_a=diff(A_v)./diff(time);
            A_a=[0 A_a];



            B_x=B(1,:);
            B_y=B(2,:);


            B_vx=diff(B_x)./diff(time);
            B_vy=diff(B_y)./diff(time);


            B_v=sqrt(B_vx.^2+B_vy.^2);
            B_v=[0 B_v];


            B_a=diff(B_v)./diff(time);
            B_a=[0 B_a];
```

```
D_x=D(1,:);
D_y=D(2,:);

D_vx=diff(D_x)./diff(time);
D_vy=diff(D_y)./diff(time);

D_v=sqrt(D_vx.^2+D_vy.^2);
D_v=[0 D_v];

D_a=diff(D_v)./diff(time);
D_a=[0 D_a];

if app.AngularvelocityDropDown.Value
    value = app.AngularvelocityDropDown.Value;
        if strcmpi(value,'ROCKER1')
              plot(time,Wc);
              ylabel('Angular velocity of rocker1 (rad/s)')
              xlabel('time (secs)')
              grid on;

        elseif strcmpi(value,'COUPLER1')
            plot(time,Wb);grid on
            ylabel('Angular velocity of coupler1 (rad/s)')
            xlabel('time (secs)')

        elseif strcmpi(value,'ROCKER2')
            plot(time,Wc1);grid on
            ylabel('Angular velocity of rocker2 (rad/s)')
```

```
            xlabel('time (secs)')


        elseif strcmpi(value,'COUPLER2')
            plot(time,Wb1);grid on
            ylabel('Angular velocity of coupler2 (rad/s)')
            xlabel('time (secs)')
        end
    end
    if app.AngularaccelarationDropDown.Value
        value2 = app.AngularaccelarationDropDown.Value;
        if strcmpi(value2,'ROCKER1')
              plot(time,Ac);
              ylabel('Angular acceleration of rocker1 (rad/s^2)')
              xlabel('time (secs)')
              grid on;
        elseif strcmpi(value2,'COUPLER1')
            plot(time,Ab);
            ylabel('Angular acceleration of coupler1 (rad/s^2)')
            xlabel('time (secs)')
            grid on;
        elseif strcmpi(value2,'ROCKER2')
            plot(time,Ac1);
            ylabel('Angular acceleration of rocker2 (rad/s^2)')
            xlabel('time (secs)')
            grid on;
        elseif strcmpi(value2,'COUPLER2')
            plot(time,Ab1);
            ylabel('Angular acceleration of coupler2 (rad/s^2)')
```

```
            xlabel('time (secs)')
            grid on;
        end
    end
    if app.NetvelocityDropDown.Value
        value3 = app.NetvelocityDropDown.Value;
        if strcmpi(value3,'Point A')
            plot(time,A_v);grid on
            ylabel('Velocity of point A (m/s)')
            xlabel('time (secs)')
        elseif strcmpi(value3,'Point B')
            plot(time,B_v);grid on
            ylabel('Velocity of point B (m/s)')
            xlabel('time (secs)')
        elseif strcmpi(value3,'Point D')
            plot(time,D_v);grid on
            ylabel('Velocity of point D (m/s)')
            xlabel('time (secs)')
        end
    end
    if app.NetaccelerationDropDown.Value
        value4 = app.NetaccelerationDropDown.Value;
        if strcmpi(value4,'Point A')
            plot(time,A_a); grid on
            ylabel('acceleration of point A (m/s^2)')
            xlabel('time (secs)')
        elseif strcmpi(value4,'Point B')
            plot(time,B_a); grid on
```

```
                ylabel('acceleration of point B (m/s^2)')
                xlabel('time (secs)')
            elseif strcmpi(value4,'Point D')
                plot(time,D_a); grid on
                ylabel('acceleration of point D (m/s^2)')
                xlabel('time (secs)')

            end
    end
end
function [check] = check_conditions_t1(app)

    l1 = app.LENGTHmmEditField.Value;
    l2 = app.LENGTHmEditField_2.Value;
    l3= app.LENGTHmEditField_3.Value;
    l4= app.LENGTHmEditField_4.Value;

    l5 = app.LENGTHmEditField_5.Value;
    l6 = app.LENGTHmEditField_6.Value;
    l7 = app.LENGTHmEditField_7.Value;

    B=[l3;l5;l6;l7];
    Q=sort(B);

    A = [l1;l2;l3;l4];
    P=sort(A);

    if(P(1)+P(4)<P(2)+P(3))
```

```
a=P(1);
b=P(4);
c=P(2);
d=P(3);
if(Q(1)+Q(4)<Q(2)+Q(3))
  if(c==Q(4))
    a1=Q(4)
    b1=Q(2)
    c1=Q(3)
    d1=Q(1)
  else
     b1=Q(1)
     c1=Q(4)
     if(P(2)==Q(2))
         a1=Q(2)
         d1 = Q(3)
     else d1 = Q(2)
          a1 = Q(3)
     end
  end
  check_1=1;
elseif(Q(1)+Q(4)>Q(2)+Q(3))                    if(c==Q(1))
         b1=Q(4)
         c1=Q(2)
         d1=Q(2)
         a1=Q(1)
         check_1=1;
     else
```

```
                    d1=Q(1);
                    a1=P(2);
                    b1=Q(4);
                    c1=Q(3);
                    check_1=1;
                end

            else check_1 = 0;

            end
        else check_1 =0;

        end

        theta1 = app.Inclinationoffixedlink1degreesEditField.Value;
        theta2 = app.Inclinationoffixedlink2degreesEditField.Value;

        Wa = app.AngularvelocityofDrivercrankradsEditField.Value;
        initial_angle =
app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value;
        time_of_running = app.DurationofanimationsecsEditField.Value;
        final_angle=initial_angle+((time_of_running*Wa)*180/pi);




        for theta=initial_angle:Wa/2:final_angle
            k=((a^2-b^2+c^2+d^2)/2);
            A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);
```

```
                B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));

                C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

                si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A));


                G=((a^2+b^2-c^2+d^2)/2);

                D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);

                E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);

                F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

                beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D));


                a1 = c;

                k1=((a1^2-b1^2+c1^2+d1^2)/2);

                A1=-a1.*(d1.*cosd(theta2)-c1).*cosd(si)+k1-(c1*d1*cosd(theta2))-
a1*d1.*sind(si).*sind(theta2);

                B1=-(2.*a1.*c1.*sind(si)-2*c1*d1.*sind(theta2));

                C1=-a1*(d1*cosd(theta2)+c1).*cosd(si)+k1+(c1*d1.*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);

                si1=2.*atand((-B1-sqrt((B1.^2)-4.*A1.*C1))./(2*A1));


                G1=((a1^2+b1^2-c1^2+d1^2)/2);

                D1=-a1.*(d1.*cosd(theta2)+b1).*cosd(si)+G1+(d1*cosd(theta2)*b1)-
a1*d1*sind(theta2).*sind(si);

                E1=2*a1*b1.*sind(si)-2*b1*d1.*sind(theta2);

                F1=-(a1.*(d1*cosd(theta2)-b1).*cosd(si))+G1-(b1*d1*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);

                beta1=2.*atand((-E1+sqrt((E1.^2)-4.*D1.*F1))./(2*D1));

            end
```

```
        if  ((imag(beta) || imag(si) || imag(beta1) || imag(si1)))

          check_2 = (~((imag(beta) || imag(si) || imag(beta1) || imag(si1)) ));
            check = (check_1 && check_2) ;

        else check_2 = 1;
            check = (check_1 && check_2) ;
        end
        return;
    end
    function create_table(app)
        l1 = app.LENGTHmmEditField.Value;
        l2 = app.LENGTHmEditField_2.Value;
        l3= app.LENGTHmEditField_3.Value;
        l4= app.LENGTHmEditField_4.Value;

        l5 = app.LENGTHmEditField_5.Value;
        l6 = app.LENGTHmEditField_6.Value;
        l7 = app.LENGTHmEditField_7.Value;

        B=[l3;l5;l6;l7];
        Q=sort(B);

        A = [l1;l2;l3;l4];
        P=sort(A);

        if(P(1)+P(4)<P(2)+P(3))
           a=P(1);
```

```
t1 = "CRANK1";
b=P(4);
t2 = "COUPLER1";
c=P(2);
t3 = "ROCKER1";
d=P(3);
t4 = "FIXED LINK1";

if(Q(1)+Q(4)<Q(2)+Q(3))
  if(c==Q(4))
    a1=Q(4);
    b1=Q(2);
    t5 = "COUPLER2";
    c1=Q(3);
    t6 = "ROCKER2";
    d1=Q(1);
    t7 = "FIXED LINK2";
  else
     b1=Q(1);
     t5 = "COUPLER2";
     c1=Q(4);
     t6 = "ROCKER2";
     if(P(2)==Q(2))
         a1=Q(2);
         d1 = Q(3);
         t7 = "FIXED LINK2";
     else d1 = Q(2);
          t7 = "FIXED LINK2";
```

```
            a1 = Q(3);
        end
    end
    check_3=1;
elseif(Q(1)+Q(4)>Q(2)+Q(3))
    if(c==Q(1))
        b1=Q(4)
        t5 = "COUPLER2";
        c1=Q(2)
        t6 = "ROCKER2";
        d1=Q(2)
        t7 = "FIXED LINK2";
        a1=Q(1)
        check_3=1;
    else
      d1=Q(1);
      t7 = "FIXED LINK2";
      a1=P(2);
      b1=Q(4);
      t5 = "COUPLER2";
      c1=Q(3);
      t6 = "ROCKER2";
      check_3=1;
    end

else check_3 = 0;

end
```

```
            else check_3 =0;


            end


            time_of_running = app.DurationofanimationsecsEditField.Value;
            delt =app.TimestepsecsEditField.Value;


            Wa = app.AngularvelocityofDrivercrankradsEditField.Value;
            theta1 = app.Inclinationoffixedlink1degreesEditField.Value;
            theta2 = app.Inclinationoffixedlink2degreesEditField.Value;
            initial_angle =
app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value;


            Aa=0;


            final_angle=initial_angle+((time_of_running*Wa)*180/pi);


            theta=initial_angle:(Wa*180/pi)/2:final_angle;
            time=linspace(0,time_of_running,length(theta));


            k=((a^2-b^2+c^2+d^2)/2);
            A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);
            B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));
            C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);
            si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A));


            G=((a^2+b^2-c^2+d^2)/2);
```

```
            D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);

            E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);

            F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

            beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D));



            a1=c;

            k1=((a1^2-b1^2+c1^2+d1^2)/2);

            A1=-a1.*(d1.*cosd(theta2)-c1).*cosd(si)+k1-(c1*d1*cosd(theta2))-
a1*d1.*sind(si).*sind(theta2);

            B1=-(2.*a1.*c1.*sind(si)-2*c1*d1.*sind(theta2));

            C1=-a1*(d1*cosd(theta2)+c1).*cosd(si)+k1+(c1*d1.*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);

            si1=2.*atand((-B1-sqrt((B1.^2)-4.*A1.*C1))./(2*A1));



            G1=((a1^2+b1^2-c1^2+d1^2)/2);

            D1=-a1.*(d1.*cosd(theta2)+b1).*cosd(si)+G1+(d1*cosd(theta2)*b1)-
a1*d1*sind(theta2).*sind(si);

            E1=2*a1*b1.*sind(si)-2*b1*d1.*sind(theta2);

            F1=-(a1.*(d1*cosd(theta2)-b1).*cosd(si))+G1-(b1*d1*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);

            beta1=2.*atand((-E1+sqrt((E1.^2)-4.*D1.*F1))./(2*D1));



            Wc=(a.*Wa.*sind(beta-theta))./(c.*sind(beta-si));

            Wb=(-a*Wa.*sind(si-theta))./(b.*sind(si-beta));

            Ab=((a.*Aa.*sind(si-theta))-(a.*(Wa.^2).*cosd(si-theta))-
(b.*(Wb.^2).*cosd(si-beta))-(c.*(Wc.^2)))./(b.*sind(beta-si));

            Ac=((a.*Aa.*sind(beta-theta))-(a.*(Wa.^2).*cosd(beta-theta))-
(b.*(Wb.^2))+(c.*(Wc.^2).*cosd(beta-si)))./(c.*sind(beta-si));

            Wc1=(a1.*Wc.*sind(beta1-si))./(c1.*sind(beta1-si1));

            Wb1=(-a1*Wc.*sind(si1-si))./(b1.*sind(si1-beta1));
```

```
            Ab1=((a1.*Ac.*sind(si1-si))-(a1.*(Wc.^2).*cosd(si1-si))-
(b1.*(Wb1.^2).*cosd(si1-beta1))-(c1.*(Wc1.^2))./(b1.*sind(beta1-si1));

            Ac1=((a1.*Ac.*sind(beta1-si))-(a1.*(Wc.^2).*cosd(beta1-si))-
(b1.*(Wb1.^2))+(c1.*(Wc1.^2).*cosd(beta1-si1)))./(c1.*sind(beta1-si1));



            %positions of each point

            O=[0;0];

            A=[a*cosd(theta);a*sind(theta)];

            B=[d*cosd(theta1)+c*cosd(si);d*sind(theta1)+c*sind(si)];

            C=[d*cosd(theta1);d*sind(theta1)];


D=[d*cosd(theta1)+c*cosd(si)+b1*cosd(beta1);d*sind(theta1)+c*sind(si)+b1*sind(beta1
)];
            E=[d*cosd(theta1)+d1*cosd(theta2);d*sind(theta1)+d1*sind(theta2)];


            A_x=A(1,:);

            A_y=A(2,:);


            A_vx=diff(A_x)./diff(time);

            A_vy=diff(A_y)./diff(time);


            A_v=sqrt(A_vx.^2+A_vy.^2);

            A_v=[0 A_v];


            A_a=diff(A_v)./diff(time);

            A_a=[0 A_a];

            B_x=B(1,:);

            B_y=B(2,:);
```

```
B_vx=diff(B_x)./diff(time);
B_vy=diff(B_y)./diff(time);

B_v=sqrt(B_vx.^2+B_vy.^2);
B_v=[0 B_v]

B_a=diff(B_v)./diff(time);
B_a=[0 B_a];
D_x=D(1,:);
D_y=D(2,:);
D_vx=diff(D_x)./diff(time);
D_vy=diff(D_y)./diff(time);
D_v=sqrt(D_vx.^2+D_vy.^2);
D_v=[0 D_v];
D_a=diff(D_v)./diff(time);
D_a=[0 D_a];
startingFolder = userpath;
filter = {'.docx';'*.dat';'*.txt';'*.m';'*.slx';'*.mat';'*.*'};
defaultFileName = fullfile(startingFolder, filter);
[baseFileName, folder] = uiputfile(defaultFileName, 'Specify a file');
if baseFileName == 0
  % User clicked the Cancel button.
  return;
end
fullFileName = fullfile(folder, baseFileName);
import mlreportgen.dom.*
d_1 = Document(fullFileName,"docx");
open(d_1);
```

```
            if d_1 ~= -1
                %1st given data table
               tableStyle = { Width("110%"), ...
                              Border("solid"), ...
                              RowSep("solid"), ...
                              ColSep("solid") };

               append(d_1,Heading1("GIVEN DATA:"));
                BodyContent = {'Time range (secs)', time_of_running; ...
                              'Time step (secs)', delt; ...
                              'Initial angle made by crank1 with horizontal
(degrees)',initial_angle; ...
                               'Angle made by fixed link1 with horizontal
(degrees)' ,theta1; ...
                               'Angle made by fixed link2 with horizontal
(degrees)' ,theta2; ...
                               'Anglular velocity of driver crank1 (rad/s) ' ,Wa};

                    tableContent_1 = [BodyContent];

                    table = Table(tableContent_1);
                    table.Style = tableStyle;

                    table.TableEntriesHAlign = "center";
                    append(d_1, table);

                    % 2nd - inputs table
                    tableStyle_1 = { Width("80%"), ...
                                   Border("solid"), ...
                                   RowSep("solid"), ...
```

```
                    ColSep("solid") };

append(d_1,Heading1("INPUTS: "));

HeaderContent = {'LINKS','LENGTH (metres)','TYPE'};
BodyContent = {'L1',a,t1;'L2',b,t2;'L3',c,t3;...
                'L4',d,t4;'L5',b1,t5;'L6',c1,t6;'L7',d1,t7};
tableContent_2 = [HeaderContent;BodyContent];

table = Table(tableContent_2);
table.Style = tableStyle_1;

table.TableEntriesHAlign = "center";
append(d_1, table);

%3rd - outputs table 1

headerContent = {'Time (secs)','CRANK1 angle with horizontal
(deg)',...
    'ROCKER1 angle(deg)','COUPLER1 angle(deg)',...
   'ROCKER2 angle(deg)','COUPLER2 angle(deg)'};
bodyContent = [time',theta',si',beta',si1',beta1'];

data_str = string(bodyContent)
%round to 2 decimal places
for i = 1:numel(data_str)
data_str(i) = sprintf('%.2f',data_str(i))
end
```

```
                    tableContent = [headerContent; data_str];


                    append(d_1,Heading1("All Table Entries Centered"));


                    table = Table(tableContent);
                    table.Style = tableStyle;


                    table.TableEntriesHAlign = "center";
                    append(d_1, table);



                   % 3rd outputs table 2
                    table_Style = { Width("100%"), ...
                                    Border("solid"), ...
                                    RowSep("solid"), ...
                                    ColSep("solid") };


                    header_Content = {'Time (secs)','Velocity_A (m/s)','Velocity_B
(m/s)','Velocity_D (m/s)',...
                                      'Acceleration_A (m/s^2)','Acceleration_B
(m/s^2)','Acceleration_D (m/s^2)' };
                    body_Content = [time',A_v',B_v',D_v',A_a',B_a',D_a'];


                    data__str = string(body_Content);
                    %round to 2 decimal places
                    for i = 1:numel(data__str)
                    data__str(i) = sprintf('%.2f',data__str(i));
                    end
```

```
            table_Content = [header_Content; data__str];



            append(d_1,Heading1("All Table Entries Centered"));

            table = Table(table_Content);
            table.Style = table_Style;

            table.TableEntriesHAlign = "center";
            append(d_1, table);

            close(d_1);



     else
        warningMessage = sprintf('Cannot open file:\n', fullFileName);
        uiwait(warndlg(warningMessage));
    end

end

function Staticforce_A(app)

    l1 = app.LENGTHmmEditField.Value;
    l2 = app.LENGTHmEditField_2.Value;
    l3= app.LENGTHmEditField_3.Value;
```

```
            l4= app.LENGTHmEditField_4.Value;


            l5 = app.LENGTHmEditField_5.Value;
            l6 = app.LENGTHmEditField_6.Value;
            l7 = app.LENGTHmEditField_7.Value;


            time_of_running = app.DurationofanimationsecsEditField.Value;
            delt =app.TimestepsecsEditField.Value;


            Wa = app.AngularvelocityofDrivercrankradsEditField.Value;
            theta1 = app.Inclinationoffixedlink1degreesEditField.Value;
            theta2 = app.Inclinationoffixedlink2degreesEditField.Value;
            initial_angle =
app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value;


            Aa=0;


            final_angle=initial_angle+((time_of_running*Wa)*180/pi);


            theta=initial_angle:(Wa*180/pi)/2:final_angle;
            time=linspace(0,time_of_running,length(theta));



            B=[l3;l5;l6;l7];
            Q=sort(B);


            A = [l1;l2;l3;l4];
            P=sort(A);
```

```
if(P(1)+P(4)<P(2)+P(3))
   a=P(1);
   b=P(4);
   c=P(2);
   d=P(3);
   if(Q(1)+Q(4)<Q(2)+Q(3))
     if(c==Q(4))
       a1=Q(4);
       b1=Q(2);
       c1=Q(3);
       d1=Q(1);
     else
        b1=Q(1);
        c1=Q(4);
        if(P(2)==Q(2))
            a1=Q(2);
            d1 = Q(3);
        else d1 = Q(2);
             a1 = Q(3);
        end
     end
     check_3=1;
   elseif(Q(1)+Q(4)>Q(2)+Q(3))
       if(c==Q(1))
            b1=Q(4)
            c1=Q(2)
            d1=Q(2)
            a1=Q(1)
```

```
                    check_3=1;
                else
                  d1=Q(1);
                  a1=P(2);
                  b1=Q(4);
                  c1=Q(3);
                  check_3=1;
                end

            else check_3 = 0;

            end
        else check_3 =0;

        end

        as=app.asEditField.Value;   Fas=app.FasEditField.Value;
thetaFas=app.thetaFasEditField.Value;
        bs=app.bsEditField.Value;  Fbs=app.FbsEditField.Value;
thetaFbs=app.thetaFbsEditField.Value;
        cs=app.csEditField.Value;   Fcs=app.FcsEditField.Value;
thetaFcs=app.thetaFcsEditField.Value;
        a1s=cs;  Fa1s=Fcs;   thetaFa1s=thetaFcs;
        b1s=app.b1sEditField.Value;  Fb1s=app.Fb1sEditField.Value;
thetaFb1s=app.thetaFb1sEditField.Value;
        c1s=app.c1sEditField.Value; Fc1s=app.Fc1sEditField.Value;
thetaFc1s=app.thetaFc1sEditField.Value;



        if as>a
```

```
                f1= errordlg("Analysis not possible");
                z=0;
            elseif bs>b
                f1 = errordlg("Analysis not possible");
                z=0;
            elseif cs>c
                f1= errordlg("Analysis not possible");
                z=0;
            elseif b1s>b1
                f1= errordlg("Analysis not possible");
                z=0;
             elseif c1s>c1
                f1= errordlg("Analysis not possible");
                z=0;
            else
                z=1;
            end


            theta=app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value;
%defined by user


            if(z==1)
            k=((a^2-b^2+c^2+d^2)/2);
            A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);
            B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));
            C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);
            si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A))
```

```
            G=((a^2+b^2-c^2+d^2)/2);

            D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);

            E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);

            F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

            beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D))


            k1=((a1^2-b1^2+c1^2+d1^2)/2);

            A1=-a1.*(d1.*cosd(theta2)-c1).*cosd(si)+k1-(c1*d1*cosd(theta2))-
a1*d1.*sind(si).*sind(theta2);

            B1=-(2.*a1.*c1.*sind(si)-2*c1*d1.*sind(theta2));

            C1=-a1*(d1*cosd(theta2)+c1).*cosd(si)+k1+(c1*d1.*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);

            si1=2.*atand((-B1-sqrt((B1.^2)-4.*A1.*C1))./(2*A1))


            G1=((a1^2+b1^2-c1^2+d1^2)/2);

            D1=-a1.*(d1.*cosd(theta2)+b1).*cosd(si)+G1+(d1*cosd(theta2)*b1)-
a1*d1*sind(theta2).*sind(si);

            E1=2*a1*b1.*sind(si)-2*b1*d1.*sind(theta2);

            F1=-(a1.*(d1*cosd(theta2)-b1).*cosd(si))+G1-(b1*d1*cosd(theta2))-
a1.*d1.*sind(si).*sind(theta2);

            beta1=2.*atand((-E1+sqrt((E1.^2)-4.*D1.*F1))./(2*D1))




            syms Fab

            moment_1=cross(as*[cosd(theta) sind(theta) 0],Fas*[cosd(thetaFas)
sind(thetaFas) 0])+cross(a*[cosd(theta) sind(theta) 0],Fab*[cosd(beta) sind(beta)
0])==0

            moment_1 = moment_1(3);

            Fab = double(rhs((isolate(moment_1,Fab))))
```

```
            Torque_1 = cross( a*[cosd(theta) sind(theta) 0], Fab*[cosd(beta)
sind(beta) 0])

            fprintf("%f Nm ",Torque_1/1000)




            syms Fab

            moment_2=cross(bs*[cosd(beta) sind(beta) 0],Fbs*[cosd(thetaFbs)
sind(thetaFbs) 0])+cross(b*[cosd(beta) sind(beta) 0],Fab*[cosd(si) sind(si) 0])==0

            moment_2 = moment_2(3);

            Fab = double(rhs((isolate(moment_2,Fab))))

            Torque_2 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(si)
sind(si) 0]))

            fprintf("%f Nm ",Torque_2/1000)




            syms Fab

            moment_3=cross(cs*[cosd(si) sind(si) 0],Fcs*[cosd(thetaFcs)
sind(thetaFcs) 0])+cross([c*cosd(si) c*sind(si) 0],Fab*[cosd(beta) sind(beta)
0])==0

            moment_3 = moment_3(3);

            Fab = double(rhs((isolate(moment_3,Fab))))

            Torque_3 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(beta)
sind(beta) 0]))

            fprintf("%f Nm ",Torque_3/1000)



            syms Fab Fcb1

            moment_eq1=cross(bs*[cosd(beta1) sind(beta1) 0],Fb1s*[cosd(thetaFb1s)
sind(thetaFb1s) 0])+cross(b1*[cosd(beta1) sind(beta1) 0],Fcb1*[cosd(si1) sind(si1)
0])==0

            moment_eq1 = moment_eq1(3);

            Fcb1 = double(rhs((isolate(moment_eq1,Fcb1))))
```

```
            moment_4=cross(Fcb1*[cosd(si1) sind(si1) 0],c*[cosd(si) sind(si)
0])+cross(Fab*[cosd(beta) sind(beta) 0],c*[cosd(si) sind(si) 0])==0

            moment_4 = moment_4(3);

            Fab = double(rhs((isolate(moment_4,Fab))))

            Torque_4 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(beta)
sind(beta) 0]))

            fprintf("%f Nm ",Torque_4/1000)


            syms Fab Fcb1

            moment_eq2=cross(cs*[cosd(si1) sind(si1) 0],Fc1s*[cosd(thetaFc1s)
sind(thetaFc1s) 0])+cross(c1*[cosd(si) sind(si) 0],Fcb1*[cosd(beta1) sind(beta1)
0])==0

            moment_eq2 = moment_eq2(3);

            Fcb1 = double(rhs((isolate(moment_eq2,Fcb1))))

            moment_5=cross(Fcb1*[cosd(beta1) sind(beta1) 0],c*[cosd(si) sind(si)
0])+cross(Fab*[cosd(beta) sind(beta) 0],c*[cosd(si) sind(si) 0])==0

            moment_5 = moment_5(3);

            Fab = double(rhs((isolate(moment_5,Fab))))

            Torque_5 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(beta)
sind(beta) 0]))

            fprintf("%f N-m ",Torque_5/1000)


            NET_TORQUE=Torque_1+Torque_2+Torque_3+Torque_4+Torque_5

            fprintf("%f N-m ",NET_TORQUE/1000)

            tor=NET_TORQUE/1000;


            end

        end

    end
```

```
    % Callbacks that handle component events
    methods (Access = private)

        % Button pushed function: CALCULATEButton
        function CALCULATEButtonPushed(app, event)

           val = check_conditions_t1(app);
            if val
                if app.VelocityandaccelerationanalysisCheckBox.Value
                     Velocity_accleration_A(app);
                elseif app.StaticforceanalysisCheckBox.Value
                     Staticforce_A(app);
                 elseif app.AnimationCheckBox.Value
                     Animation_t1(app);
                end
            else f = errordlg('The given inputs do not the match the conditions
required for the mechanism','Invalid Inputs');

            end

        end

        % Button pushed function: SAVEASButton
        function SAVEASButtonPushed(app, event)

           create_table(app);

        end
```

```
        % Button pushed function: RESETButton
        function RESETButtonPushed(app, event)
            %set(handles.my_edit_box,'String','');
%             clc;
%             clear all;
            close all;
            app.DurationofanimationsecsEditField.Value = 0;
            app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value =0;
            app.Inclinationoffixedlink2degreesEditField.Value=0;
            app.AngularvelocityofDrivercrankradsEditField.Value=0;
            app.Inclinationoffixedlink1degreesEditField.Value=0;
            app.TimestepsecsEditField.Value=0;
            app.LENGTHmEditField_4.Value=0;
            app.LENGTHmEditField_3.Value=0;
            app.LENGTHmEditField_2.Value=0;
            app.LENGTHmmEditField.Value=0;
            app.LENGTHmEditField_5.Value=0;
            app.LENGTHmEditField_6.Value=0;
            app.LENGTHmEditField_7.Value=0;

            app.NetaccelerationDropDown.Value=app.NetaccelerationDropDown.Items(1);
            app.NetvelocityDropDown.Value=app.NetvelocityDropDown.Items(1);
            app.AngularaccelarationDropDown.Value =
app.AngularaccelarationDropDown.Items(1);
            app.AngularvelocityDropDown.Value=app.AngularvelocityDropDown.Items(1);
%             app.TYPEDropDown.Value=app.TYPEDropDown.Items(1);
            app.AnimationCheckBox.Value = false;
            app.VelocityandaccelerationanalysisCheckBox.Value = false;
            app.StaticforceanalysisCheckBox.Value = false;
```

```
        end
        % Button pushed function: CLOSEButton
        function CLOSEButtonPushed(app, event)
            delete(app);
        end
    end

    % Component initialization
    methods (Access = private)

        % Create UIFigure and components
        function createComponents(app)

            % Create UIFigure and hide until all components are created
            app.UIFigure = uifigure('Visible', 'off');
            app.UIFigure.Position = [100 100 923 565];
            app.UIFigure.Name = 'MATLAB App';

            % Create INPUTLabel
            app.INPUTLabel = uilabel(app.UIFigure);
            app.INPUTLabel.Position = [190 524 106 26];
            app.INPUTLabel.Text = 'INPUT';

            % Create LENGTHmmEditFieldLabel
            app.LENGTHmmEditFieldLabel = uilabel(app.UIFigure);
            app.LENGTHmmEditFieldLabel.HorizontalAlignment = 'right';
            app.LENGTHmmEditFieldLabel.Position = [27 460 82 22];
            app.LENGTHmmEditFieldLabel.Text = 'LENGTH(mm)';
```

```
% Create LENGTHmmEditField
app.LENGTHmmEditField = uieditfield(app.UIFigure, 'numeric');
app.LENGTHmmEditField.Position = [118 456 69 29];

% Create L1Label_2
app.L1Label_2 = uilabel(app.UIFigure);
app.L1Label_2.Position = [42 485 101 30];
app.L1Label_2.Text = 'L1';

% Create L2Label_2
app.L2Label_2 = uilabel(app.UIFigure);
app.L2Label_2.Position = [40 414 58 23];
app.L2Label_2.Text = 'L2';

% Create LENGTHmEditField_2Label
app.LENGTHmEditField_2Label = uilabel(app.UIFigure);
app.LENGTHmEditField_2Label.HorizontalAlignment = 'right';
app.LENGTHmEditField_2Label.Position = [43 386 71 22];
app.LENGTHmEditField_2Label.Text = 'LENGTH(m)';

% Create LENGTHmEditField_2
app.LENGTHmEditField_2 = uieditfield(app.UIFigure, 'numeric');
app.LENGTHmEditField_2.Position = [123 382 69 29];

% Create L3Label_2
app.L3Label_2 = uilabel(app.UIFigure);
app.L3Label_2.Position = [38 338 58 23];
```

```
app.L3Label_2.Text = 'L3';

% Create LENGTHmEditField_3Label
app.LENGTHmEditField_3Label = uilabel(app.UIFigure);
app.LENGTHmEditField_3Label.HorizontalAlignment = 'right';
app.LENGTHmEditField_3Label.Position = [38 313 71 22];
app.LENGTHmEditField_3Label.Text = 'LENGTH(m)';

% Create LENGTHmEditField_3
app.LENGTHmEditField_3 = uieditfield(app.UIFigure, 'numeric');
app.LENGTHmEditField_3.Position = [118 310 69 29];

% Create L4Label_2
app.L4Label_2 = uilabel(app.UIFigure);
app.L4Label_2.Position = [38 265 58 23];
app.L4Label_2.Text = 'L4';

% Create LENGTHmEditField_4Label
app.LENGTHmEditField_4Label = uilabel(app.UIFigure);
app.LENGTHmEditField_4Label.HorizontalAlignment = 'right';
app.LENGTHmEditField_4Label.Position = [42 240 71 22];
app.LENGTHmEditField_4Label.Text = 'LENGTH(m)';

% Create LENGTHmEditField_4
app.LENGTHmEditField_4 = uieditfield(app.UIFigure, 'numeric');
app.LENGTHmEditField_4.Position = [122 237 69 29];

% Create ANALYSISLabel
```

```
            app.ANALYSISLabel = uilabel(app.UIFigure);
            app.ANALYSISLabel.Position = [718 513 60 37];
            app.ANALYSISLabel.Text = 'ANALYSIS';

            % Create TIMEINTERVALLabel
            app.TIMEINTERVALLabel = uilabel(app.UIFigure);
            app.TIMEINTERVALLabel.Position = [331 485 96 40];
            app.TIMEINTERVALLabel.Text = 'TIME INTERVAL';

            % Create DurationofanimationsecsEditFieldLabel
            app.DurationofanimationsecsEditFieldLabel = uilabel(app.UIFigure);
            app.DurationofanimationsecsEditFieldLabel.HorizontalAlignment =
'right';
            app.DurationofanimationsecsEditFieldLabel.Position = [232 455 152 22];
            app.DurationofanimationsecsEditFieldLabel.Text = 'Duration of
animation(secs)';

            % Create DurationofanimationsecsEditField
            app.DurationofanimationsecsEditField = uieditfield(app.UIFigure,
'numeric');
            app.DurationofanimationsecsEditField.Position = [399 451 48 30];

            % Create TimestepsecsEditFieldLabel
            app.TimestepsecsEditFieldLabel = uilabel(app.UIFigure);
            app.TimestepsecsEditFieldLabel.HorizontalAlignment = 'right';
            app.TimestepsecsEditFieldLabel.Position = [457 454 91 22];
            app.TimestepsecsEditFieldLabel.Text = 'Time step(secs)';

            % Create TimestepsecsEditField
            app.TimestepsecsEditField = uieditfield(app.UIFigure, 'numeric');
```

```
            app.TimestepsecsEditField.Position = [563 450 48 30];

            % Create ANGLEVARIATIONLabel
            app.ANGLEVARIATIONLabel = uilabel(app.UIFigure);
            app.ANGLEVARIATIONLabel.Position = [331 386 112 40];
            app.ANGLEVARIATIONLabel.Text = 'ANGLE VARIATION';

            % Create Inclinationoffixedlink1degreesEditFieldLabel
            app.Inclinationoffixedlink1degreesEditFieldLabel =
uilabel(app.UIFigure);
            app.Inclinationoffixedlink1degreesEditFieldLabel.HorizontalAlignment =
'right';
            app.Inclinationoffixedlink1degreesEditFieldLabel.Position = [268 330
181 22];
            app.Inclinationoffixedlink1degreesEditFieldLabel.Text = 'Inclination of
fixed link1(degrees)';

            % Create Inclinationoffixedlink1degreesEditField
            app.Inclinationoffixedlink1degreesEditField = uieditfield(app.UIFigure,
'numeric');
            app.Inclinationoffixedlink1degreesEditField.Position = [464 326 48 30];

            % Create VelocityandaccelerationanalysisCheckBox
            app.VelocityandaccelerationanalysisCheckBox = uicheckbox(app.UIFigure);
            app.VelocityandaccelerationanalysisCheckBox.Text = 'Velocity and
acceleration analysis';
            app.VelocityandaccelerationanalysisCheckBox.Position = [666 450 203
32];

            % Create StaticforceanalysisCheckBox
            app.StaticforceanalysisCheckBox = uicheckbox(app.UIFigure);
```

```
            app.StaticforceanalysisCheckBox.Text = 'Static force analysis';
            app.StaticforceanalysisCheckBox.Position = [666 421 188 32];

            % Create CALCULATEButton
            app.CALCULATEButton = uibutton(app.UIFigure, 'push');
            app.CALCULATEButton.ButtonPushedFcn = createCallbackFcn(app,
@CALCULATEButtonPushed, true);
            app.CALCULATEButton.Position = [563 19 137 31];
            app.CALCULATEButton.Text = 'CALCULATE';

            % Create SAVEASButton
            app.SAVEASButton = uibutton(app.UIFigure, 'push');
            app.SAVEASButton.ButtonPushedFcn = createCallbackFcn(app,
@SAVEASButtonPushed, true);
            app.SAVEASButton.Position = [405 14 143 35];
            app.SAVEASButton.Text = 'SAVE AS';

            % Create RESETButton
            app.RESETButton = uibutton(app.UIFigure, 'push');
            app.RESETButton.ButtonPushedFcn = createCallbackFcn(app,
@RESETButtonPushed, true);
            app.RESETButton.Position = [232 14 149 35];
            app.RESETButton.Text = 'RESET';

            % Create CLOSEButton
            app.CLOSEButton = uibutton(app.UIFigure, 'push');
            app.CLOSEButton.ButtonPushedFcn = createCallbackFcn(app,
@CLOSEButtonPushed, true);
            app.CLOSEButton.Position = [723 21 142 35];
            app.CLOSEButton.Text = 'CLOSE';
```

```
            % Create AngularvelocityofDrivercrankradsEditFieldLabel
            app.AngularvelocityofDrivercrankradsEditFieldLabel =
uilabel(app.UIFigure);
            app.AngularvelocityofDrivercrankradsEditFieldLabel.HorizontalAlignment
= 'right';
            app.AngularvelocityofDrivercrankradsEditFieldLabel.Position = [263 267
204 29];
            app.AngularvelocityofDrivercrankradsEditFieldLabel.Text = 'Angular
velocity of Driver crank(rad/s)';

            % Create AngularvelocityofDrivercrankradsEditField
            app.AngularvelocityofDrivercrankradsEditField =
uieditfield(app.UIFigure, 'numeric');
            app.AngularvelocityofDrivercrankradsEditField.Position = [466 268 45
30];

            % Create L5Label_2
            app.L5Label_2 = uilabel(app.UIFigure);
            app.L5Label_2.Position = [38 198 58 23];
            app.L5Label_2.Text = 'L5';

            % Create L6Label_2
            app.L6Label_2 = uilabel(app.UIFigure);
            app.L6Label_2.Position = [38 122 58 23];
            app.L6Label_2.Text = 'L6';

            % Create L7Label
            app.L7Label = uilabel(app.UIFigure);
            app.L7Label.Position = [38 49 58 23];
            app.L7Label.Text = 'L7';
```

```
% Create LENGTHmEditField_5Label
app.LENGTHmEditField_5Label = uilabel(app.UIFigure);
app.LENGTHmEditField_5Label.HorizontalAlignment = 'right';
app.LENGTHmEditField_5Label.Position = [42 170 71 22];
app.LENGTHmEditField_5Label.Text = 'LENGTH(m)';

% Create LENGTHmEditField_5
app.LENGTHmEditField_5 = uieditfield(app.UIFigure, 'numeric');
app.LENGTHmEditField_5.Position = [122 167 69 29];

% Create LENGTHmEditField_6Label
app.LENGTHmEditField_6Label = uilabel(app.UIFigure);
app.LENGTHmEditField_6Label.HorizontalAlignment = 'right';
app.LENGTHmEditField_6Label.Position = [38 97 71 22];
app.LENGTHmEditField_6Label.Text = 'LENGTH(m)';

% Create LENGTHmEditField_6
app.LENGTHmEditField_6 = uieditfield(app.UIFigure, 'numeric');
app.LENGTHmEditField_6.Position = [118 94 69 29];

% Create LENGTHmEditField_7Label
app.LENGTHmEditField_7Label = uilabel(app.UIFigure);
app.LENGTHmEditField_7Label.HorizontalAlignment = 'right';
app.LENGTHmEditField_7Label.Position = [42 27 71 22];
app.LENGTHmEditField_7Label.Text = 'LENGTH(m)';

% Create LENGTHmEditField_7
```

```
            app.LENGTHmEditField_7 = uieditfield(app.UIFigure, 'numeric');

            app.LENGTHmEditField_7.Position = [122 24 69 29];


            % Create Inclinationoffixedlink2degreesEditFieldLabel

            app.Inclinationoffixedlink2degreesEditFieldLabel =
uilabel(app.UIFigure);

            app.Inclinationoffixedlink2degreesEditFieldLabel.HorizontalAlignment =
'right';

            app.Inclinationoffixedlink2degreesEditFieldLabel.Position = [268 301
181 22];

            app.Inclinationoffixedlink2degreesEditFieldLabel.Text = 'Inclination of
fixed link2(degrees)';


            % Create Inclinationoffixedlink2degreesEditField

            app.Inclinationoffixedlink2degreesEditField = uieditfield(app.UIFigure,
'numeric');

            app.Inclinationoffixedlink2degreesEditField.Position = [464 297 48 30];


            % Create AnimationCheckBox

            app.AnimationCheckBox = uicheckbox(app.UIFigure);

            app.AnimationCheckBox.Text = 'Animation';

            app.AnimationCheckBox.Position = [666 390 188 32];


            % Create Initialanglemadebycrank1withhorizontaldegreesEditFieldLabel

            app.Initialanglemadebycrank1withhorizontaldegreesEditFieldLabel =
uilabel(app.UIFigure);


app.Initialanglemadebycrank1withhorizontaldegreesEditFieldLabel.HorizontalAlignment
= 'right';


app.Initialanglemadebycrank1withhorizontaldegreesEditFieldLabel.Position = [232 359
298 22];
```

```
            app.Initialanglemadebycrank1withhorizontaldegreesEditFieldLabel.Text =
'Initial angle made by crank1 with horizontal(degrees)';


            % Create Initialanglemadebycrank1withhorizontaldegreesEditField

            app.Initialanglemadebycrank1withhorizontaldegreesEditField =
uieditfield(app.UIFigure, 'numeric');

            app.Initialanglemadebycrank1withhorizontaldegreesEditField.Position =
[537 355 48 30];


            % Create PLOTSLabel

            app.PLOTSLabel = uilabel(app.UIFigure);

            app.PLOTSLabel.Position = [723 360 73 24];

            app.PLOTSLabel.Text = 'PLOTS';


            % Create AngularvelocityDropDownLabel

            app.AngularvelocityDropDownLabel = uilabel(app.UIFigure);

            app.AngularvelocityDropDownLabel.HorizontalAlignment = 'right';

            app.AngularvelocityDropDownLabel.Position = [658 334 90 22];

            app.AngularvelocityDropDownLabel.Text = 'Angular velocity';


            % Create AngularvelocityDropDown

            app.AngularvelocityDropDown = uidropdown(app.UIFigure);

            app.AngularvelocityDropDown.Items = {'Select', 'ROCKER1', 'COUPLER1',
'ROCKER2', 'COUPLER2'};

            app.AngularvelocityDropDown.Position = [763 334 106 22];

            app.AngularvelocityDropDown.Value = 'Select';


            % Create AngularaccelarationDropDownLabel

            app.AngularaccelarationDropDownLabel = uilabel(app.UIFigure);

            app.AngularaccelarationDropDownLabel.HorizontalAlignment = 'right';
```

```
            app.AngularaccelarationDropDownLabel.Position = [633 313 115 22];
            app.AngularaccelarationDropDownLabel.Text = 'Angular accelaration';

            % Create AngularaccelarationDropDown
            app.AngularaccelarationDropDown = uidropdown(app.UIFigure);
            app.AngularaccelarationDropDown.Items = {'Select', 'ROCKER1',
'COUPLER1', 'ROCKER2', 'COUPLER2'};
            app.AngularaccelarationDropDown.Position = [763 313 106 22];
            app.AngularaccelarationDropDown.Value = 'Select';

            % Create NetvelocityDropDownLabel
            app.NetvelocityDropDownLabel = uilabel(app.UIFigure);
            app.NetvelocityDropDownLabel.HorizontalAlignment = 'right';
            app.NetvelocityDropDownLabel.Position = [681 289 67 22];
            app.NetvelocityDropDownLabel.Text = 'Net velocity';

            % Create NetvelocityDropDown
            app.NetvelocityDropDown = uidropdown(app.UIFigure);
            app.NetvelocityDropDown.Items = {'Select', 'Point A', 'Point B', 'Point
D'};
            app.NetvelocityDropDown.Position = [763 289 106 22];
            app.NetvelocityDropDown.Value = 'Select';

            % Create NetaccelerationDropDownLabel
            app.NetaccelerationDropDownLabel = uilabel(app.UIFigure);
            app.NetaccelerationDropDownLabel.HorizontalAlignment = 'right';
            app.NetaccelerationDropDownLabel.Position = [656 268 92 22];
            app.NetaccelerationDropDownLabel.Text = 'Net acceleration';
```

```
            % Create NetaccelerationDropDown
            app.NetaccelerationDropDown = uidropdown(app.UIFigure);
            app.NetaccelerationDropDown.Items = {'Select', 'Point A', 'PointB',
'Point D'};
            app.NetaccelerationDropDown.Position = [763 268 106 22];
            app.NetaccelerationDropDown.Value = 'Select';

            % Create TYPEDropDown_8Label
            app.TYPEDropDown_8Label = uilabel(app.UIFigure);
            app.TYPEDropDown_8Label.HorizontalAlignment = 'right';
            app.TYPEDropDown_8Label.Position = [35 361 65 22];
            app.TYPEDropDown_8Label.Text = 'TYPE';

            % Create TYPEDropDown_8
            app.TYPEDropDown_8 = uidropdown(app.UIFigure);
            app.TYPEDropDown_8.Items = {'Select', 'CRANK1', 'COUPLER1', 'ROCKER1',
'FIXED LINK1', 'FIXED LINK2', 'COUPLER2', 'ROCKER2'};
            app.TYPEDropDown_8.Position = [115 361 81 22];
            app.TYPEDropDown_8.Value = 'Select';

            % Create TYPEDropDown_9Label
            app.TYPEDropDown_9Label = uilabel(app.UIFigure);
            app.TYPEDropDown_9Label.HorizontalAlignment = 'right';
            app.TYPEDropDown_9Label.Position = [32 288 65 22];
            app.TYPEDropDown_9Label.Text = 'TYPE';

            % Create TYPEDropDown_9
            app.TYPEDropDown_9 = uidropdown(app.UIFigure);
            app.TYPEDropDown_9.Items = {'Select', 'CRANK1', 'COUPLER1', 'ROCKER1',
'FIXED LINK1', 'FIXED LINK2', 'COUPLER2', 'ROCKER2'};
```

```
            app.TYPEDropDown_9.Position = [112 288 81 22];
            app.TYPEDropDown_9.Value = 'Select';

            % Create TYPEDropDown_10Label
            app.TYPEDropDown_10Label = uilabel(app.UIFigure);
            app.TYPEDropDown_10Label.HorizontalAlignment = 'right';
            app.TYPEDropDown_10Label.Position = [31 216 65 22];
            app.TYPEDropDown_10Label.Text = 'TYPE';

            % Create TYPEDropDown_10
            app.TYPEDropDown_10 = uidropdown(app.UIFigure);
            app.TYPEDropDown_10.Items = {'Select', 'CRANK1', 'COUPLER1', 'ROCKER1',
'FIXED LINK1', 'FIXED LINK2', 'COUPLER2', 'ROCKER2'};
            app.TYPEDropDown_10.Position = [99 216 93 22];
            app.TYPEDropDown_10.Value = 'Select';

            % Create TYPEDropDown_11Label
            app.TYPEDropDown_11Label = uilabel(app.UIFigure);
            app.TYPEDropDown_11Label.HorizontalAlignment = 'right';
            app.TYPEDropDown_11Label.Position = [32 146 65 22];
            app.TYPEDropDown_11Label.Text = 'TYPE';

            % Create TYPEDropDown_11
            app.TYPEDropDown_11 = uidropdown(app.UIFigure);
            app.TYPEDropDown_11.Items = {'Select', 'CRANK1', 'COUPLER1', 'ROCKER1',
'FIXED LINK1', 'FIXED LINK2', 'COUPLER2', 'ROCKER2'};
            app.TYPEDropDown_11.Position = [112 146 81 22];
            app.TYPEDropDown_11.Value = 'Select';
```

```
            % Create TYPEDropDown_12Label
            app.TYPEDropDown_12Label = uilabel(app.UIFigure);
            app.TYPEDropDown_12Label.HorizontalAlignment = 'right';
            app.TYPEDropDown_12Label.Position = [28 73 65 22];
            app.TYPEDropDown_12Label.Text = 'TYPE';

            % Create TYPEDropDown_12
            app.TYPEDropDown_12 = uidropdown(app.UIFigure);
            app.TYPEDropDown_12.Items = {'Select', 'CRANK1', 'COUPLER1', 'ROCKER1',
'FIXED LINK1', 'FIXED LINK2', 'COUPLER2', 'ROCKER2'};
            app.TYPEDropDown_12.Position = [108 73 81 22];
            app.TYPEDropDown_12.Value = 'Select';

            % Create TYPEDropDown_13Label
            app.TYPEDropDown_13Label = uilabel(app.UIFigure);
            app.TYPEDropDown_13Label.HorizontalAlignment = 'right';
            app.TYPEDropDown_13Label.Position = [33 3 65 22];
            app.TYPEDropDown_13Label.Text = 'TYPE';

            % Create TYPEDropDown_13
            app.TYPEDropDown_13 = uidropdown(app.UIFigure);
            app.TYPEDropDown_13.Items = {'Select', 'CRANK1', 'COUPLER1', 'ROCKER1',
'FIXED LINK1', 'FIXED LINK2', 'COUPLER2', 'ROCKER2'};
            app.TYPEDropDown_13.Position = [113 3 81 22];
            app.TYPEDropDown_13.Value = 'Select';

            % Create FasEditFieldLabel
            app.FasEditFieldLabel = uilabel(app.UIFigure);
            app.FasEditFieldLabel.HorizontalAlignment = 'right';
```

```
app.FasEditFieldLabel.Position = [311 221 26 22];
app.FasEditFieldLabel.Text = 'Fas';

% Create FasEditField
app.FasEditField = uieditfield(app.UIFigure, 'numeric');
app.FasEditField.Position = [349 216 35 32];

% Create FbsEditFieldLabel
app.FbsEditFieldLabel = uilabel(app.UIFigure);
app.FbsEditFieldLabel.HorizontalAlignment = 'right';
app.FbsEditFieldLabel.Position = [311 190 26 22];
app.FbsEditFieldLabel.Text = 'Fbs';

% Create FbsEditField
app.FbsEditField = uieditfield(app.UIFigure, 'numeric');
app.FbsEditField.Position = [349 185 35 32];

% Create FcsEditFieldLabel
app.FcsEditFieldLabel = uilabel(app.UIFigure);
app.FcsEditFieldLabel.HorizontalAlignment = 'right';
app.FcsEditFieldLabel.Position = [312 159 25 22];
app.FcsEditFieldLabel.Text = 'Fcs';

% Create FcsEditField
app.FcsEditField = uieditfield(app.UIFigure, 'numeric');
app.FcsEditField.Position = [349 154 35 32];

% Create Fb1sEditFieldLabel
```

```
app.Fb1sEditFieldLabel = uilabel(app.UIFigure);
app.Fb1sEditFieldLabel.HorizontalAlignment = 'right';
app.Fb1sEditFieldLabel.Position = [306 127 32 22];
app.Fb1sEditFieldLabel.Text = 'Fb1s';

% Create Fb1sEditField
app.Fb1sEditField = uieditfield(app.UIFigure, 'numeric');
app.Fb1sEditField.Position = [350 122 35 32];

% Create Fc1sEditFieldLabel
app.Fc1sEditFieldLabel = uilabel(app.UIFigure);
app.Fc1sEditFieldLabel.HorizontalAlignment = 'right';
app.Fc1sEditFieldLabel.Position = [307 96 31 22];
app.Fc1sEditFieldLabel.Text = 'Fc1s';

% Create Fc1sEditField
app.Fc1sEditField = uieditfield(app.UIFigure, 'numeric');
app.Fc1sEditField.Position = [350 91 35 32];

% Create asEditFieldLabel
app.asEditFieldLabel = uilabel(app.UIFigure);
app.asEditFieldLabel.HorizontalAlignment = 'right';
app.asEditFieldLabel.Position = [406 221 25 22];
app.asEditFieldLabel.Text = 'as';

% Create asEditField
app.asEditField = uieditfield(app.UIFigure, 'numeric');
app.asEditField.Position = [443 216 35 32];
```

```
% Create bsEditFieldLabel
app.bsEditFieldLabel = uilabel(app.UIFigure);
app.bsEditFieldLabel.HorizontalAlignment = 'right';
app.bsEditFieldLabel.Position = [405 190 25 22];
app.bsEditFieldLabel.Text = 'bs';

% Create bsEditField
app.bsEditField = uieditfield(app.UIFigure, 'numeric');
app.bsEditField.Position = [442 185 35 32];

% Create csEditFieldLabel
app.csEditFieldLabel = uilabel(app.UIFigure);
app.csEditFieldLabel.HorizontalAlignment = 'right';
app.csEditFieldLabel.Position = [405 159 25 22];
app.csEditFieldLabel.Text = 'cs';

% Create csEditField
app.csEditField = uieditfield(app.UIFigure, 'numeric');
app.csEditField.Position = [442 154 35 32];

% Create b1sEditFieldLabel
app.b1sEditFieldLabel = uilabel(app.UIFigure);
app.b1sEditFieldLabel.HorizontalAlignment = 'right';
app.b1sEditFieldLabel.Position = [405 127 25 22];
app.b1sEditFieldLabel.Text = 'b1s';

% Create b1sEditField
```

```
app.b1sEditField = uieditfield(app.UIFigure, 'numeric');
app.b1sEditField.Position = [442 122 35 32];

% Create c1sEditFieldLabel
app.c1sEditFieldLabel = uilabel(app.UIFigure);
app.c1sEditFieldLabel.HorizontalAlignment = 'right';
app.c1sEditFieldLabel.Position = [405 96 25 22];
app.c1sEditFieldLabel.Text = 'c1s';

% Create c1sEditField
app.c1sEditField = uieditfield(app.UIFigure, 'numeric');
app.c1sEditField.Position = [442 91 35 32];

% Create thetaFasEditFieldLabel
app.thetaFasEditFieldLabel = uilabel(app.UIFigure);
app.thetaFasEditFieldLabel.HorizontalAlignment = 'right';
app.thetaFasEditFieldLabel.Position = [478 221 52 22];
app.thetaFasEditFieldLabel.Text = 'thetaFas';

% Create thetaFasEditField
app.thetaFasEditField = uieditfield(app.UIFigure, 'numeric');
app.thetaFasEditField.Position = [542 216 35 32];

% Create thetaFbsEditFieldLabel
app.thetaFbsEditFieldLabel = uilabel(app.UIFigure);
app.thetaFbsEditFieldLabel.HorizontalAlignment = 'right';
app.thetaFbsEditFieldLabel.Position = [478 190 52 22];
app.thetaFbsEditFieldLabel.Text = 'thetaFbs';
```

```
% Create thetaFbsEditField
app.thetaFbsEditField = uieditfield(app.UIFigure, 'numeric');
app.thetaFbsEditField.Position = [542 185 35 32];

% Create thetaFcsEditFieldLabel
app.thetaFcsEditFieldLabel = uilabel(app.UIFigure);
app.thetaFcsEditFieldLabel.HorizontalAlignment = 'right';
app.thetaFcsEditFieldLabel.Position = [479 159 51 22];
app.thetaFcsEditFieldLabel.Text = 'thetaFcs';

% Create thetaFcsEditField
app.thetaFcsEditField = uieditfield(app.UIFigure, 'numeric');
app.thetaFcsEditField.Position = [542 154 35 32];

% Create thetaFb1sEditFieldLabel
app.thetaFb1sEditFieldLabel = uilabel(app.UIFigure);
app.thetaFb1sEditFieldLabel.HorizontalAlignment = 'right';
app.thetaFb1sEditFieldLabel.Position = [471 128 59 22];
app.thetaFb1sEditFieldLabel.Text = 'thetaFb1s';

% Create thetaFb1sEditField
app.thetaFb1sEditField = uieditfield(app.UIFigure, 'numeric');
app.thetaFb1sEditField.Position = [542 123 35 32];

% Create thetaFc1sEditFieldLabel
app.thetaFc1sEditFieldLabel = uilabel(app.UIFigure);
app.thetaFc1sEditFieldLabel.HorizontalAlignment = 'right';
```

```
            app.thetaFc1sEditFieldLabel.Position = [472 97 58 22];
            app.thetaFc1sEditFieldLabel.Text = 'thetaFc1s';

            % Create thetaFc1sEditField
            app.thetaFc1sEditField = uieditfield(app.UIFigure, 'numeric');
            app.thetaFc1sEditField.Position = [542 92 35 32];

            % Show the figure after all components are created
            app.UIFigure.Visible = 'on';
        end
    end

    % App creation and deletion
    methods (Access = public)

        % Construct app
        function app = Variable_Stroke_mechanism_t1_exported

            % Create UIFigure and components
            createComponents(app)

            % Register the app with App Designer
            registerApp(app, app.UIFigure)

            if nargout == 0
                clear app
            end
        end
```

```
        % Code that executes before app deletion
        function delete(app)

            % Delete UIFigure when app is deleted
            delete(app.UIFigure)
        end
    end
end
```

VARIABLE STROKE MECHANISM TYPE -2

```
classdef Variable_stroke_mechanism_t2_exported < matlab.apps.AppBase


    % Properties that correspond to app components
    properties (Access = public)
        UIFigure                        matlab.ui.Figure
        thetaFssEditField               matlab.ui.control.NumericEditField
        thetaFssEditFieldLabel          matlab.ui.control.Label
        thetaFcrsEditField              matlab.ui.control.NumericEditField
        thetaFcrsEditFieldLabel         matlab.ui.control.Label
        thetaFcsEditField               matlab.ui.control.NumericEditField
        thetaFcsEditFieldLabel          matlab.ui.control.Label
        thetaFbsEditField               matlab.ui.control.NumericEditField
        thetaFbsEditFieldLabel          matlab.ui.control.Label
        thetaFasEditField               matlab.ui.control.NumericEditField
        thetaFasEditFieldLabel          matlab.ui.control.Label
        FssEditField                    matlab.ui.control.NumericEditField
        FssEditFieldLabel               matlab.ui.control.Label
        FcrsEditField                   matlab.ui.control.NumericEditField
        FcrsEditFieldLabel              matlab.ui.control.Label
        FcsEditField                    matlab.ui.control.NumericEditField
        FcsEditFieldLabel               matlab.ui.control.Label
        FbsEditField                    matlab.ui.control.NumericEditField
        FbsEditFieldLabel               matlab.ui.control.Label
        FasEditField                    matlab.ui.control.NumericEditField
        FasEditFieldLabel               matlab.ui.control.Label
        crsEditField                    matlab.ui.control.NumericEditField
```

```
        crsEditFieldLabel             matlab.ui.control.Label
        csEditField                   matlab.ui.control.NumericEditField
        csEditFieldLabel              matlab.ui.control.Label
        bsEditField                   matlab.ui.control.NumericEditField
        bsEditFieldLabel              matlab.ui.control.Label
        asEditField                   matlab.ui.control.NumericEditField
        asEditFieldLabel              matlab.ui.control.Label
        TYPEDropDown_17               matlab.ui.control.DropDown
        TYPEDropDown_17Label          matlab.ui.control.Label
        TYPEDropDown_16               matlab.ui.control.DropDown
        TYPEDropDown_16Label          matlab.ui.control.Label
        TYPEDropDown_15               matlab.ui.control.DropDown
        TYPEDropDown_15Label          matlab.ui.control.Label
        TYPEDropDown_14               matlab.ui.control.DropDown
        TYPEDropDown_14Label          matlab.ui.control.Label
        TYPEDropDown_13               matlab.ui.control.DropDown
        TYPEDropDown_13Label          matlab.ui.control.Label
        TYPEDropDown_7                matlab.ui.control.DropDown
        TYPEDropDown_7Label           matlab.ui.control.Label
        NetaccelerationDropDown       matlab.ui.control.DropDown
        NetaccelerationDropDownLabel  matlab.ui.control.Label
        NetvelocityDropDown           matlab.ui.control.DropDown
        NetvelocityDropDownLabel      matlab.ui.control.Label
        ANALYSISLabel                 matlab.ui.control.Label
        AngularvelocityofDrivercrankradsEditField
matlab.ui.control.NumericEditField
        AngularvelocityofDrivercrankradsEditFieldLabel_2  matlab.ui.control.Label
        InclinationoffixedlinkdegreesEditField  matlab.ui.control.NumericEditField
        InclinationoffixedlinkdegreesEditFieldLabel  matlab.ui.control.Label
```

Initialanglemadebycrank1withhorizontaldegreesEditField matlab.ui.control.NumericEditField

Initialanglemadebycrank1withhorizontaldegreesEditFieldLabel matlab.ui.control.Label

DurationofanimationsecsEditField matlab.ui.control.NumericEditField

DurationofanimationsecsEditFieldLabel matlab.ui.control.Label

TimestepsecsEditField matlab.ui.control.NumericEditField

TimestepsecsEditFieldLabel matlab.ui.control.Label

AnimationCheckBox matlab.ui.control.CheckBox

CLOSEButton matlab.ui.control.Button

RESETButton matlab.ui.control.Button

SAVEASButton matlab.ui.control.Button

CALCULATEButton matlab.ui.control.Button

StaticforceanalysisCheckBox matlab.ui.control.CheckBox

VelocityandaccelerationanalysisCheckBox matlab.ui.control.CheckBox

ANGLEVARIATIONLabel matlab.ui.control.Label

TIMEINTERVALLabel matlab.ui.control.Label

LENGTHmEditField_6 matlab.ui.control.NumericEditField

LENGTHmEditField_6Label matlab.ui.control.Label

L6Label matlab.ui.control.Label

LENGTHmEditField_5 matlab.ui.control.NumericEditField

LENGTHmEditField_5Label matlab.ui.control.Label

L5Label matlab.ui.control.Label

LENGTHmEditField_4 matlab.ui.control.NumericEditField

LENGTHmEditField_4Label matlab.ui.control.Label

L4Label matlab.ui.control.Label

LENGTHmEditField_3 matlab.ui.control.NumericEditField

LENGTHmEditField_3Label matlab.ui.control.Label

L3Label matlab.ui.control.Label

```
        LENGTHmEditField_2            matlab.ui.control.NumericEditField
        LENGTHmEditField_2Label       matlab.ui.control.Label
        L2Label                       matlab.ui.control.Label
        LENGTHmEditField              matlab.ui.control.NumericEditField
        LENGTHmEditFieldLabel         matlab.ui.control.Label
        L1Label                       matlab.ui.control.Label
        INPUTLabel                    matlab.ui.control.Label
    end

     methods (Access = public)

        function Animation_t2(app)
                a=app.LENGTHmEditField.Value; %crank
                b=app.LENGTHmEditField_2.Value;  % coupler
                c=app.LENGTHmEditField_3.Value;  %rocker
                d=app.LENGTHmEditField_4.Value;  % fixed link
                cr=app.LENGTHmEditField_5.Value;  % coupler2
                e=app.LENGTHmEditField_6.Value;   %offset;

                theta1=app.InclinationoffixedlinkdegreesEditField.Value;
                Wa=app.AngularvelocityofDrivercrankradsEditField.Value; %pi/10
initial_angle=app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value;
                time_of_running=app.DurationofanimationsecsEditField.Value;
                delt = app.TimestepsecsEditField.Value;

                final_angle=initial_angle+(time_of_running*Wa*180/pi);

                for theta=initial_angle:delt:final_angle
```

```
k=((a^2-b^2+c^2+d^2)/2);

A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);

B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));

C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A));


G=((a^2+b^2-c^2+d^2)/2);

D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);

E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);

F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D));


theta3=asind((e-c.*sind(si))./(cr));


plot([-150 900],[e e],'go-','LineWidth',1);hold on;


plot([0 a*cosd(theta)], [0 a*sind(theta)],'ko-','LineWidth',2);hold
on;

plot([d*cosd(theta1) d*cosd(theta1)+c*cosd(si)], [d*sind(theta1)
d*sind(theta1)+c*sind(si)], 'bo-','LineWidth',2); hold on;

plot([0 d*cosd(theta1)], [0 d*sind(theta1)], 'mo-','LineWidth',2);
hold on;

plot([a*cosd(theta) a*cosd(theta)+b*cosd(beta)], [a*sind(theta)
a*sind(theta)+b*sind(beta)], 'ro-','LineWidth',2);hold on;

rectangle('position',[d+c*cosd(si)+cr*cosd(theta3)-50 e-50 100
100],'FaceColor','c');hold on

plot([d*cosd(theta1)+c*cosd(si) d+c*cosd(si)+cr*cosd(theta3)],
[d*sind(theta1)+c*sind(si) e], 'yo-','LineWidth',2);hold off;
```

```
            grid on
            axis([-150 900 -150 900]);
            pbaspect([1 1 1]);
            pause(0.01);
            drawnow
            end
        end

        function Velocity_accleration_At2(app)
            a=app.LENGTHmEditField.Value; %crank
            b=app.LENGTHmEditField_2.Value;  % coupler
            c=app.LENGTHmEditField_3.Value;  %rocker
            d=app.LENGTHmEditField_4.Value;  % fixed link
            cr=app.LENGTHmEditField_5.Value;  % coupler2
            e=app.LENGTHmEditField_6.Value;   %offset;

            theta1=app.InclinationoffixedlinkdegreesEditField.Value;
            Wa=app.AngularvelocityofDrivercrankradsEditField.Value; %pi/10
initial_angle=app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value;
            time_of_running=app.DurationofanimationsecsEditField.Value;
            delt = app.TimestepsecsEditField.Value;
            final_angle=initial_angle+(time_of_running*Wa*180/pi);

            theta=initial_angle:delt:final_angle;
            Aa = 0;
            time=linspace(0,time_of_running,length(theta));
            k=((a^2-b^2+c^2+d^2)/2);
```

```
            A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);

            B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));

            C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

            si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A));



            G=((a^2+b^2-c^2+d^2)/2);

            D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);

            E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);

            F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

            beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D));

            theta3=asind((e-c.*sind(si))./(cr));



            Wc=(a.*Wa.*sind(beta-theta))./(c.*sind(beta-si));

            Wb=(-a*Wa.*sind(si-theta))./(b.*sind(si-beta));

            Ab=((a.*Aa.*sind(si-theta))-(a.*(Wa.^2).*cosd(si-theta))-
(b.*(Wb.^2).*cosd(si-beta))-(c.*(Wc.^2)))./(b.*sind(beta-si));

            Ac=((a.*Aa.*sind(beta-theta))-(a.*(Wa.^2).*cosd(beta-theta))-
(b.*(Wb.^2))+(c.*(Wc.^2).*cosd(beta-si)))./(c.*sind(beta-si));

            Wcr=-(c*Wc.*cosd(si))./(cr.*cosd(theta3));

            v=((c*Wc.*sind(theta3-si))./(cosd(theta3)));




            a3=(c*(Wc.^2).*sind(si)+cr.*(Wcr.^2).*sind(theta3)-
c.*Ac.*cos(theta3))./cr.*cosd(theta3);

            a_piston=(c.*Ac.*sind(theta3-si)-c.*(Wc.^2).*cosd(theta3-si)-
cr.*(Wcr.^2))./cosd(theta3);
```

```
%positions of each point
O=[0;0];
A=[a*cosd(theta);a*sind(theta)];
B=[d*cosd(theta1)+c*cosd(si);d*sind(theta1)+c*sind(si)];

A_x=A(1,:);
A_y=A(2,:);

A_vx=diff(A_x)./diff(time);
A_vy=diff(A_y)./diff(time);

A_v=sqrt(A_vx.^2+A_vy.^2);
A_v=[0 A_v];

A_a=diff(A_v)./diff(time);
A_a=[0 A_a];

B_x=B(1,:);
B_y=B(2,:);

B_vx=diff(B_x)./diff(time);
B_vy=diff(B_y)./diff(time);

B_v=sqrt(B_vx.^2+B_vy.^2);
B_v=[0 B_v];

B_a=diff(B_v)./diff(time);
B_a=[0 B_a];
```

```
if app.NetvelocityDropDown.Value
     value3 = app.NetvelocityDropDown.Value;
        if strcmpi(value3,'Point A')
              plot(time,A_v);grid on
              ylabel('Velocity of point A (m/s)')
              xlabel('time (secs)')
        elseif strcmpi(value3,'Point B')
             plot(time,B_v);grid on
              ylabel('Velocity of point B (m/s)')
              xlabel('time (secs)')
        elseif strcmpi(value3,'Slider')
                plot(time,v)
                grid on
                xlabel('time (secs)')
                ylabel('velocity of slider (m/s)')
        end
end


if app.NetaccelerationDropDown.Value
    value4 = app.NetaccelerationDropDown.Value;
        if strcmpi(value4,'Point A')
              plot(time,A_a); grid on
              ylabel('acceleration of point A (m/s^2)')
              xlabel('time (secs)')
        elseif strcmpi(value4,'Point B')
```

```
                    plot(time,B_a); grid on
                    ylabel('acceleration of point B (m/s^2)')
                    xlabel('time (secs)')
                elseif strcmpi(value4,'Slider')
                    plot(time,a_piston)
                     grid on
                     xlabel('time (secs)')
                     ylabel('acceleration of the slider (m/s^2)')

                end
            end
        end



        function [ch] = check_conditions_t2(app)
            a=app.LENGTHmEditField.Value; %crank
            b=app.LENGTHmEditField_2.Value;  % coupler
            c=app.LENGTHmEditField_3.Value;  %rocker
            d=app.LENGTHmEditField_4.Value;  % fixed link
            cr=app.LENGTHmEditField_5.Value;  % coupler2
            e=app.LENGTHmEditField_6.Value;   %offset;

            theta1=app.InclinationoffixedlinkdegreesEditField.Value;
            Wa=app.AngularvelocityofDrivercrankradsEditField.Value; %pi/10
initial_angle=app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value;
            time_of_running=app.DurationofanimationsecsEditField.Value;
            delt = app.TimestepsecsEditField.Value;
```

```
            final_angle=initial_angle+time_of_running*Wa;
            for theta=initial_angle:delt:final_angle;


                k=((a^2-b^2+c^2+d^2)/2);
                A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);
                B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));
                C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);
                si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A));


                G=((a^2+b^2-c^2+d^2)/2);
                D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);
                E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);
                F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);
                beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D));
                theta3=asind((e-c.*sind(si))./(cr));
            end
            v1 = strcmpi(app.TYPEDropDown_7.Value,'CRANK');
            v2 = strcmpi(app.TYPEDropDown_13.Value,'COUPLER');
            v3 = strcmpi(app.TYPEDropDown_14.Value,'ROCKER');
            v4 = strcmpi(app.TYPEDropDown_15.Value,'FIXED LINK');
            v5 = strcmpi(app.TYPEDropDown_16.Value,'COUPLER2');
            v6 = strcmpi(app.TYPEDropDown_17.Value,'OFFSET');


            if  ((imag(beta) || imag(si) || imag(theta3)) && (~(v1 && v2 && v3 &&
v4 && v5 && v6)))
```

```
                ch = (~((imag(beta) || imag(si) || imag(theta3)) && (~(v1 && v2 &&
v3 && v4 && v5 && v6))));


            else  ch = 1;


            end

            return;

        end




        function Staticforce_At2(app)


            a=app.LENGTHmEditField.Value; %crank

            b=app.LENGTHmEditField_2.Value;  % coupler

            c=app.LENGTHmEditField_3.Value;  %rocker

            d=app.LENGTHmEditField_4.Value;  % fixed link

            cr=app.LENGTHmEditField_5.Value;  % coupler2

            e=app.LENGTHmEditField_6.Value;   %offset;


            theta1=app.InclinationoffixedlinkdegreesEditField.Value;

            Wa=app.AngularvelocityofDrivercrankradsEditField.Value; %pi/10

initial_angle=app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value;

            time_of_running=app.DurationofanimationsecsEditField.Value;

            delt = app.TimestepsecsEditField.Value;


            final_angle=initial_angle+time_of_running*Wa;
```

```
as = app.asEditField.Value;
bs = app.bsEditField.Value;
cs = app.csEditField.Value;
crs = app.crsEditField.Value;
Fas = app.FasEditField.Value;
Fbs = app.FbsEditField.Value;
Fcrs = app.FcrsEditField.Value;
Fcs = app.FcsEditField.Value;
Fss = app.FssEditField.Value;
thetaFcs=app.thetaFcsEditField.Value;
thetaFbs=app.thetaFbsEditField.Value;
thetaFcrs=app.thetaFcrsEditField.Value;
thetaFss = app.thetaFssEditField.Value;
thetaFas=app.thetaFasEditField.Value;

if as>a
     f1= errordlg("Analysis not possible");
     z=0;
elseif bs>b
     f1= errordlg("Analysis not possible");
     z=0;
elseif cs>c
     f1= errordlg("Analysis not possible");
     z=0;
elseif crs>cr
     f1= errordlg("Analysis not possible");
     z=0;
else  z=1;
```

```
            end


            theta=app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value;
%defined by user

            if(z==1)

            k=((a^2-b^2+c^2+d^2)/2);

            A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);

            B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));

            C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

            si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A));



            G=((a^2+b^2-c^2+d^2)/2);

            D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);

            E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);

            F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

            beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D));




            theta3=asind((e-c.*sind(si))./(cr));


            syms Fab

            moment_1=cross(as*[cosd(theta) sind(theta) 0],Fas*[cosd(thetaFas)
sind(thetaFas) 0])+cross(a*[cosd(theta) sind(theta) 0],Fab*[cosd(beta) sind(beta)
0])==0

            moment_1 = moment_1(3);

            Fab = double(rhs((isolate(moment_1,Fab))))
```

```
            Torque_1 = cross( a*[cosd(theta) sind(theta) 0], Fab*[cosd(beta)
sind(beta) 0])

            fprintf("%f Nm ",Torque_1/1000)




            syms Fab

            moment_2=cross([bs*cosd(beta) bs*sind(beta) 0],Fbs*[cosd(thetaFbs)
sind(thetaFbs) 0])+cross([b*cosd(beta) b*sind(beta) 0],Fab*[cosd(si) sind(si)
0])==0

            moment_2 = moment_2(3);

            Fab = double(rhs((isolate(moment_2,Fab))))

            Torque_2 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(beta)
sind(beta) 0]))

            fprintf("%f Nm ",Torque_2/1000)



            syms Fab

            moment_3=cross(cs*[cosd(si) sind(si) 0],Fcs*[cosd(thetaFcs)
sind(thetaFcs) 0])+cross([c*cosd(si) c*sind(si) 0],Fab*[cosd(beta) sind(beta)
0])==0

            moment_3 = moment_3(3);

            Fab = double(rhs((isolate(moment_3,Fab))))

            Torque_3 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(si)
sind(si) 0]))

            fprintf("%f Nm ",Torque_3/1000)



            syms Fab  F

            Fx = Fss + F*cosd(theta3) ==0;

            Fbd = double(rhs(vpa(isolate(Fx,F))))

            moment_4=cross(c*[cosd(si) sind(si) 0],Fbd*[cosd(theta3) sind(theta3)
0])+cross(c*[cosd(si) sind(si) 0],Fab*[cosd(beta) sind(beta) 0])==0

            moment_4 = moment_4(3);

            Fab = double(rhs((isolate(moment_4,Fab))))
```

```
            Torque_4 = cross( a*[cosd(theta) sind(theta) 0], Fab*([cosd(beta)
sind(beta) 0]))
            fprintf("%f Nm ",Torque_4/1000)

            NET_TORQUE=Torque_1+Torque_2+Torque_3+Torque_4
            fprintf("%f Nm ",NET_TORQUE/1000)
            end

        end

        function create_outputfile(app)
            a=app.LENGTHmEditField.Value; %crank
            b=app.LENGTHmEditField_2.Value;  % coupler
            c=app.LENGTHmEditField_3.Value;  %rocker
            d=app.LENGTHmEditField_4.Value;  % fixed link
            cr=app.LENGTHmEditField_5.Value;  % coupler2
            e=app.LENGTHmEditField_6.Value;   %offset;

            theta1=app.InclinationoffixedlinkdegreesEditField.Value;
            Wa=app.AngularvelocityofDrivercrankradsEditField.Value; %pi/10

initial_angle=app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value;
            time_of_running=app.DurationofanimationsecsEditField.Value;
            delt = app.TimestepsecsEditField.Value;
            final_angle=initial_angle+(time_of_running*Wa*180/pi);

            theta=initial_angle:delt:final_angle;
            Aa = 0;
            time=linspace(0,time_of_running,length(theta));
```

```
            k=((a^2-b^2+c^2+d^2)/2);

            A=-a.*(d.*cosd(theta1)-c).*cosd(theta)+k-(c*d*cosd(theta1))-
a*d.*sind(theta).*sind(theta1);

            B=-(2.*a.*c.*sind(theta)-2*c*d.*sind(theta1));

            C=-a*(d*cosd(theta1)+c).*cosd(theta)+k+(c*d.*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

            si=2.*atand((-B-sqrt((B.^2)-4.*A.*C))./(2*A));


            G=((a^2+b^2-c^2+d^2)/2);

            D=-a.*(d.*cosd(theta1)+b).*cosd(theta)+G+(d*cosd(theta1)*b)-
a*d*sind(theta1).*sind(theta);

            E=2*a*b.*sind(theta)-2*b*d.*sind(theta1);

            F=-(a.*(d*cosd(theta1)-b).*cosd(theta))+G-(b*d*cosd(theta1))-
a.*d.*sind(theta).*sind(theta1);

            beta=2.*atand((-E+sqrt((E.^2)-4.*D.*F))./(2*D));

            theta3=asind((e-c.*sind(si))./(cr));


            Wc=(a.*Wa.*sind(beta-theta))./(c.*sind(beta-si));

            Wb=(-a*Wa.*sind(si-theta))./(b.*sind(si-beta));

            Ab=((a.*Aa.*sind(si-theta))-(a.*(Wa.^2).*cosd(si-theta))-
(b.*(Wb.^2).*cosd(si-beta))-(c.*(Wc.^2)))./(b.*sind(beta-si));

            Ac=((a.*Aa.*sind(beta-theta))-(a.*(Wa.^2).*cosd(beta-theta))-
(b.*(Wb.^2))+(c.*(Wc.^2).*cosd(beta-si)))./(c.*sind(beta-si));

            Wcr=-(c*Wc.*cosd(si))./(cr.*cosd(theta3));

            v=((c*Wc.*sind(theta3-si))./(cosd(theta3)));




            a3=(c*(Wc.^2).*sind(si)+cr.*(Wcr.^2).*sind(theta3)-
c.*Ac.*cos(theta3))./cr.*cosd(theta3);

            a_piston=(c.*Ac.*sind(theta3-si)-c.*(Wc.^2).*cosd(theta3-si)-
cr.*(Wcr.^2))./cosd(theta3);

            %positions of each point
```

```
O=[0;0];
A=[a*cosd(theta);a*sind(theta)];
B=[d*cosd(theta1)+c*cosd(si);d*sind(theta1)+c*sind(si)];

A_x=A(1,:);
A_y=A(2,:);

A_vx=diff(A_x)./diff(time);
A_vy=diff(A_y)./diff(time);

A_v=sqrt(A_vx.^2+A_vy.^2);
A_v=[0 A_v];

A_a=diff(A_v)./diff(time);
A_a=[0 A_a];

B_x=B(1,:);
B_y=B(2,:);

B_vx=diff(B_x)./diff(time);
B_vy=diff(B_y)./diff(time);

B_v=sqrt(B_vx.^2+B_vy.^2);
B_v=[0 B_v];

B_a=diff(B_v)./diff(time);
B_a=[0 B_a];
t_1 = app.TYPEDropDown_7.Value;
```

```
t_2 = app.TYPEDropDown_13.Value;
t_3 = app.TYPEDropDown_14.Value;
t_4 = app.TYPEDropDown_15.Value;
t_5 = app.TYPEDropDown_16.Value;
t_6 = app.TYPEDropDown_17.Value;

startingFolder = userpath;
filter = {'.docx';'*.dat';'*.txt';'*.m';'*.slx';'*.mat';'*.*'};
defaultFileName = fullfile(startingFolder, filter);
[baseFileName, folder] = uiputfile(defaultFileName, 'Specify a file');
if baseFileName == 0
  % User clicked the Cancel button.
  return;
end
fullFileName = fullfile(folder, baseFileName);
import mlreportgen.dom.*
d_2 = Document(fullFileName,"docx");
open(d_2);
if d_2 ~= -1
    %1st given data table
   tableStyle = { Width("110%"), ...
                  Border("solid"), ...
                  RowSep("solid"), ...
                  ColSep("solid") };

   append(d_2,Heading1("GIVEN DATA:"));
    BodyContent = {'Time range (secs)', time_of_running; ...
                  'Time step (secs)', delt; ...
```

```
                                'Initial angle made by crank1 with horizontal
(degrees)',initial_angle; ...
                                 'Angle made by fixed link with horizontal
(degrees)' ,theta1; ...
                                 'Anglular velocity of driver crank1 (rad/s) ' ,Wa};

                    tableContent_1 = [BodyContent];

                    table = Table(tableContent_1);
                    table.Style = tableStyle;

                    table.TableEntriesHAlign = "center";
                    append(d_2, table);

                    % 2nd - inputs table
                    tableStyle_1 = { Width("70%"), ...
                                     Border("solid"), ...
                                     RowSep("solid"), ...
                                     ColSep("solid") };

                    append(d_2,Heading1("INPUTS: "));

                    HeaderContent = {'LINKS','LENGTH (metres)','TYPE'};
                    BodyContent = {'L1',a,t_1;'L2',b,t_2;'L3',c,t_3;...
                                    'L4',d,t_4;'L5',cr,t_5;'L6',e,t_6;};
                    tableContent_2 = [HeaderContent;BodyContent];

                    table = Table(tableContent_2);
                    table.Style = tableStyle_1;
```

```
table.TableEntriesHAlign = "center";
append(d_2, table);

%3rd - outputs table 1

headerContent = {'Time (secs)','CRANK angle with horizontal
(deg)',...
    'ROCKER angle(deg)','COUPLER angle(deg)','COUPLER2
angle(deg)'};
bodyContent = [time',theta',si',beta',theta3'];

data_str = string(bodyContent)
%round to 2 decimal places
for i = 1:numel(data_str)
data_str(i) = sprintf('%.2f',data_str(i))
end

tableContent = [headerContent; data_str];

append(d_2,Heading1("All Table Entries Centered"));

table = Table(tableContent);
table.Style = tableStyle;

table.TableEntriesHAlign = "center";
append(d_2, table);
```

```
                % 3rd outputs table 2
                 table_Style = { Width("100%"), ...
                                 Border("solid"), ...
                                 RowSep("solid"), ...
                                 ColSep("solid") };

                 header_Content = {'Time (secs)','Velocity_A (m/s)','Velocity_B
(m/s)','Velocity of slider (m/s)',...
                                   'Acceleration_A (m/s^2)','Acceleration_B
(m/s^2)','Acceleration of slider (m/s^2)' };
                 body_Content = [time',A_v',B_v',v',A_a',B_a',a_piston'];

                 data__str = string(body_Content);
                 %round to 2 decimal places
                 for i = 1:numel(data__str)
                 data__str(i) = sprintf('%.2f',data__str(i));
                 end


                 table_Content = [header_Content; data__str];


                 append(d_2,Heading1("All Table Entries Centered"));

                 table = Table(table_Content);
                 table.Style = table_Style;

                 table.TableEntriesHAlign = "center";
                 append(d_2, table);
```

```
                close(d_2);
            else
                warningMessage = sprintf('Cannot open file:\n', fullFileName);
                uiwait(warndlg(warningMessage));

        end
    end
end

    % Callbacks that handle component events
    methods (Access = private)

        % Button pushed function: CALCULATEButton
        function CALCULATEButtonPushed(app, event)
            val = check_conditions_t2(app);
            if val
                if app.VelocityandaccelerationanalysisCheckBox.Value
                    Velocity_accleration_At2(app);
                elseif app.StaticforceanalysisCheckBox.Value
                    Staticforce_At2(app);
                 elseif app.AnimationCheckBox.Value
                    Animation_t2(app);
                end
            else f = errordlg('The given inputs do not the match the conditions
required for the mechanism','Invalid Inputs');

            end
        end
```

```
% Button pushed function: SAVEASButton
function SAVEASButtonPushed(app, event)
    create_outputfile(app);
end

% Button pushed function: CLOSEButton
function CLOSEButtonPushed(app, event)
    delete(app)
end

% Button pushed function: RESETButton
function RESETButtonPushed(app, event)

    app.DurationofanimationsecsEditField.Value = 0;
    app.Initialanglemadebycrank1withhorizontaldegreesEditField.Value =0;
    app.AngularvelocityofDrivercrankradsEditField.Value=0;
    app.InclinationoffixedlinkdegreesEditField.Value = 0;
    app.TimestepsecsEditField.Value=0;
    app.LENGTHmEditField_4.Value=0;
    app.LENGTHmEditField_3.Value=0;
    app.LENGTHmEditField_2.Value=0;
    app.LENGTHmEditField.Value=0;
    app.LENGTHmEditField_5.Value=0;
    app.LENGTHmEditField_6.Value=0;
    app.TYPEDropDown_7.Value = app.TYPEDropDown_12.Items(1);
    app.TYPEDropDown_13.Value = app.TYPEDropDown_11.Items(1);
    app.TYPEDropDown_14.Value = app.TYPEDropDown_10.Items(1);
```

```
            app.TYPEDropDown_15.Value = app.TYPEDropDown_9.Items(1);
            app.TYPEDropDown_16.Value = app.TYPEDropDown_8.Items(1);
            app.TYPEDropDown_17.Value=app.TYPEDropDown_7.Items(1);
            app.NetaccelerationDropDown.Value=app.NetaccelerationDropDown.Items(1);
            app.NetvelocityDropDown.Value=app.NetvelocityDropDown.Items(1);
            app.AnimationCheckBox.Value = false;
            app.VelocityandaccelerationanalysisCheckBox.Value = false;
            app.StaticforceanalysisCheckBox.Value = false;

        end
    end

    % Component initialization
    methods (Access = private)

        % Create UIFigure and components
        function createComponents(app)

            % Create UIFigure and hide until all components are created
            app.UIFigure = uifigure('Visible', 'off');
            app.UIFigure.Position = [100 100 890 513];
            app.UIFigure.Name = 'MATLAB App';

            % Create INPUTLabel
            app.INPUTLabel = uilabel(app.UIFigure);
            app.INPUTLabel.Position = [107 481 140 32];
            app.INPUTLabel.Text = 'INPUT';
```

```
% Create L1Label
app.L1Label = uilabel(app.UIFigure);
app.L1Label.Position = [30 443 101 30];
app.L1Label.Text = 'L1';

% Create LENGTHmEditFieldLabel
app.LENGTHmEditFieldLabel = uilabel(app.UIFigure);
app.LENGTHmEditFieldLabel.HorizontalAlignment = 'right';
app.LENGTHmEditFieldLabel.Position = [53 447 71 22];
app.LENGTHmEditFieldLabel.Text = 'LENGTH(m)';

% Create LENGTHmEditField
app.LENGTHmEditField = uieditfield(app.UIFigure, 'numeric');
app.LENGTHmEditField.Position = [133 443 69 29];

% Create L2Label
app.L2Label = uilabel(app.UIFigure);
app.L2Label.Position = [30 370 58 23];
app.L2Label.Text = 'L2';

% Create LENGTHmEditField_2Label
app.LENGTHmEditField_2Label = uilabel(app.UIFigure);
app.LENGTHmEditField_2Label.HorizontalAlignment = 'right';
app.LENGTHmEditField_2Label.Position = [57 374 71 22];
app.LENGTHmEditField_2Label.Text = 'LENGTH(m)';

% Create LENGTHmEditField_2
app.LENGTHmEditField_2 = uieditfield(app.UIFigure, 'numeric');
```

```
app.LENGTHmEditField_2.Position = [137 370 69 29];

% Create L3Label
app.L3Label = uilabel(app.UIFigure);
app.L3Label.Position = [30 300 58 23];
app.L3Label.Text = 'L3';

% Create LENGTHmEditField_3Label
app.LENGTHmEditField_3Label = uilabel(app.UIFigure);
app.LENGTHmEditField_3Label.HorizontalAlignment = 'right';
app.LENGTHmEditField_3Label.Position = [53 297 71 22];
app.LENGTHmEditField_3Label.Text = 'LENGTH(m)';

% Create LENGTHmEditField_3
app.LENGTHmEditField_3 = uieditfield(app.UIFigure, 'numeric');
app.LENGTHmEditField_3.Position = [133 294 69 29];

% Create L4Label
app.L4Label = uilabel(app.UIFigure);
app.L4Label.Position = [30 227 58 23];
app.L4Label.Text = 'L4';

% Create LENGTHmEditField_4Label
app.LENGTHmEditField_4Label = uilabel(app.UIFigure);
app.LENGTHmEditField_4Label.HorizontalAlignment = 'right';
app.LENGTHmEditField_4Label.Position = [47 227 71 22];
app.LENGTHmEditField_4Label.Text = 'LENGTH(m)';
% Create LENGTHmEditField_4
```

```
app.LENGTHmEditField_4 = uieditfield(app.UIFigure, 'numeric');
app.LENGTHmEditField_4.Position = [127 224 69 29];

% Create L5Label
app.L5Label = uilabel(app.UIFigure);
app.L5Label.Position = [30 152 58 23];
app.L5Label.Text = 'L5';

% Create LENGTHmEditField_5Label
app.LENGTHmEditField_5Label = uilabel(app.UIFigure);
app.LENGTHmEditField_5Label.HorizontalAlignment = 'right';
app.LENGTHmEditField_5Label.Position = [53 155 71 22];
app.LENGTHmEditField_5Label.Text = 'LENGTH(m)';

% Create LENGTHmEditField_5
app.LENGTHmEditField_5 = uieditfield(app.UIFigure, 'numeric');
app.LENGTHmEditField_5.Position = [133 152 69 29];

% Create L6Label
app.L6Label = uilabel(app.UIFigure);
app.L6Label.Position = [30 94 58 23];
app.L6Label.Text = 'L6';

% Create LENGTHmEditField_6Label
app.LENGTHmEditField_6Label = uilabel(app.UIFigure);
app.LENGTHmEditField_6Label.HorizontalAlignment = 'right';
app.LENGTHmEditField_6Label.Position = [50 93 71 22];
app.LENGTHmEditField_6Label.Text = 'LENGTH(m)';
```

```
            % Create LENGTHmEditField_6
            app.LENGTHmEditField_6 = uieditfield(app.UIFigure, 'numeric');
            app.LENGTHmEditField_6.Position = [130 90 69 29];

            % Create TIMEINTERVALLabel
            app.TIMEINTERVALLabel = uilabel(app.UIFigure);
            app.TIMEINTERVALLabel.Position = [340 472 96 40];
            app.TIMEINTERVALLabel.Text = 'TIME INTERVAL';

            % Create ANGLEVARIATIONLabel
            app.ANGLEVARIATIONLabel = uilabel(app.UIFigure);
            app.ANGLEVARIATIONLabel.Position = [367 328 112 40];
            app.ANGLEVARIATIONLabel.Text = 'ANGLE VARIATION';

            % Create VelocityandaccelerationanalysisCheckBox
            app.VelocityandaccelerationanalysisCheckBox = uicheckbox(app.UIFigure);
            app.VelocityandaccelerationanalysisCheckBox.Text = 'Velocity and
acceleration analysis';
            app.VelocityandaccelerationanalysisCheckBox.Position = [666 434 203
32];

            % Create StaticforceanalysisCheckBox
            app.StaticforceanalysisCheckBox = uicheckbox(app.UIFigure);
            app.StaticforceanalysisCheckBox.Text = 'Static force analysis';
            app.StaticforceanalysisCheckBox.Position = [666 403 188 32];

            % Create CALCULATEButton
            app.CALCULATEButton = uibutton(app.UIFigure, 'push');
```

```
            app.CALCULATEButton.ButtonPushedFcn = createCallbackFcn(app,
@CALCULATEButtonPushed, true);

            app.CALCULATEButton.Position = [682 256 137 31];

            app.CALCULATEButton.Text = 'CALCULATE';


            % Create SAVEASButton

            app.SAVEASButton = uibutton(app.UIFigure, 'push');

            app.SAVEASButton.ButtonPushedFcn = createCallbackFcn(app,
@SAVEASButtonPushed, true);

            app.SAVEASButton.Position = [679 152 143 35];

            app.SAVEASButton.Text = 'SAVE AS';


            % Create RESETButton

            app.RESETButton = uibutton(app.UIFigure, 'push');

            app.RESETButton.ButtonPushedFcn = createCallbackFcn(app,
@RESETButtonPushed, true);

            app.RESETButton.Position = [679 35 149 35];

            app.RESETButton.Text = 'RESET';


            % Create CLOSEButton

            app.CLOSEButton = uibutton(app.UIFigure, 'push');

            app.CLOSEButton.ButtonPushedFcn = createCallbackFcn(app,
@CLOSEButtonPushed, true);

            app.CLOSEButton.Position = [677 93 142 35];

            app.CLOSEButton.Text = 'CLOSE';


            % Create AnimationCheckBox

            app.AnimationCheckBox = uicheckbox(app.UIFigure);

            app.AnimationCheckBox.Text = 'Animation';

            app.AnimationCheckBox.Position = [666 372 188 32];
```

```
            % Create TimestepsecsEditFieldLabel
            app.TimestepsecsEditFieldLabel = uilabel(app.UIFigure);
            app.TimestepsecsEditFieldLabel.HorizontalAlignment = 'right';
            app.TimestepsecsEditFieldLabel.Position = [329 390 91 22];
            app.TimestepsecsEditFieldLabel.Text = 'Time step(secs)';

            % Create TimestepsecsEditField
            app.TimestepsecsEditField = uieditfield(app.UIFigure, 'numeric');
            app.TimestepsecsEditField.Position = [435 386 48 30];

            % Create DurationofanimationsecsEditFieldLabel
            app.DurationofanimationsecsEditFieldLabel = uilabel(app.UIFigure);
            app.DurationofanimationsecsEditFieldLabel.HorizontalAlignment =
'right';
            app.DurationofanimationsecsEditFieldLabel.Position = [268 427 152 22];
            app.DurationofanimationsecsEditFieldLabel.Text = 'Duration of
animation(secs)';

            % Create DurationofanimationsecsEditField
            app.DurationofanimationsecsEditField = uieditfield(app.UIFigure,
'numeric');
            app.DurationofanimationsecsEditField.Position = [435 423 48 30];

            % Create Initialanglemadebycrank1withhorizontaldegreesEditFieldLabel
            app.Initialanglemadebycrank1withhorizontaldegreesEditFieldLabel =
uilabel(app.UIFigure);

app.Initialanglemadebycrank1withhorizontaldegreesEditFieldLabel.HorizontalAlignment
= 'right';
```

```
app.Initialanglemadebycrank1withhorizontaldegreesEditFieldLabel.Position = [219 297
290 22];

            app.Initialanglemadebycrank1withhorizontaldegreesEditFieldLabel.Text =
'Initial angle made by crank1 with horizontal(degrees)';


            % Create Initialanglemadebycrank1withhorizontaldegreesEditField

            app.Initialanglemadebycrank1withhorizontaldegreesEditField =
uieditfield(app.UIFigure, 'numeric');

            app.Initialanglemadebycrank1withhorizontaldegreesEditField.Position =
[524 293 48 30];


            % Create InclinationoffixedlinkdegreesEditFieldLabel

            app.InclinationoffixedlinkdegreesEditFieldLabel =
uilabel(app.UIFigure);

            app.InclinationoffixedlinkdegreesEditFieldLabel.HorizontalAlignment =
'right';

            app.InclinationoffixedlinkdegreesEditFieldLabel.Position = [288 235 174
22];

            app.InclinationoffixedlinkdegreesEditFieldLabel.Text = 'Inclination of
fixed link(degrees)';


            % Create InclinationoffixedlinkdegreesEditField

            app.InclinationoffixedlinkdegreesEditField = uieditfield(app.UIFigure,
'numeric');

            app.InclinationoffixedlinkdegreesEditField.Position = [477 231 48 30];


            % Create AngularvelocityofDrivercrankradsEditFieldLabel_2

            app.AngularvelocityofDrivercrankradsEditFieldLabel_2 =
uilabel(app.UIFigure);


app.AngularvelocityofDrivercrankradsEditFieldLabel_2.HorizontalAlignment = 'right';

            app.AngularvelocityofDrivercrankradsEditFieldLabel_2.Position = [277
194 204 29];
```

```
            app.AngularvelocityofDrivercrankradsEditFieldLabel_2.Text = 'Angular
velocity of Driver crank(rad/s)';


            % Create AngularvelocityofDrivercrankradsEditField

            app.AngularvelocityofDrivercrankradsEditField =
uieditfield(app.UIFigure, 'numeric');

            app.AngularvelocityofDrivercrankradsEditField.Position = [480 195 45
30];


            % Create ANALYSISLabel

            app.ANALYSISLabel = uilabel(app.UIFigure);

            app.ANALYSISLabel.Position = [718 465 60 37];

            app.ANALYSISLabel.Text = 'ANALYSIS';


            % Create NetvelocityDropDownLabel

            app.NetvelocityDropDownLabel = uilabel(app.UIFigure);

            app.NetvelocityDropDownLabel.HorizontalAlignment = 'right';

            app.NetvelocityDropDownLabel.Position = [666 337 67 22];

            app.NetvelocityDropDownLabel.Text = 'Net velocity';


            % Create NetvelocityDropDown

            app.NetvelocityDropDown = uidropdown(app.UIFigure);

            app.NetvelocityDropDown.Items = {'Select', 'Point A', 'Point B',
'Slider'};

            app.NetvelocityDropDown.Position = [748 337 106 22];

            app.NetvelocityDropDown.Value = 'Select';


            % Create NetaccelerationDropDownLabel

            app.NetaccelerationDropDownLabel = uilabel(app.UIFigure);

            app.NetaccelerationDropDownLabel.HorizontalAlignment = 'right';
```

```
            app.NetaccelerationDropDownLabel.Position = [644 307 92 22];
            app.NetaccelerationDropDownLabel.Text = 'Net acceleration';

            % Create NetaccelerationDropDown
            app.NetaccelerationDropDown = uidropdown(app.UIFigure);
            app.NetaccelerationDropDown.Items = {'Select', 'Point A', 'PointB',
'Slider'};
            app.NetaccelerationDropDown.Position = [751 307 106 22];
            app.NetaccelerationDropDown.Value = 'Select';

            % Create TYPEDropDown_7Label
            app.TYPEDropDown_7Label = uilabel(app.UIFigure);
            app.TYPEDropDown_7Label.HorizontalAlignment = 'right';
            app.TYPEDropDown_7Label.Position = [41 422 65 22];
            app.TYPEDropDown_7Label.Text = 'TYPE';

            % Create TYPEDropDown_7
            app.TYPEDropDown_7 = uidropdown(app.UIFigure);
            app.TYPEDropDown_7.Items = {'Select', 'CRANK', 'COUPLER', 'ROCKER',
'FIXED LINK', 'COUPLER2', 'OFFSET'};
            app.TYPEDropDown_7.Position = [121 422 81 22];
            app.TYPEDropDown_7.Value = 'Select';

            % Create TYPEDropDown_13Label
            app.TYPEDropDown_13Label = uilabel(app.UIFigure);
            app.TYPEDropDown_13Label.HorizontalAlignment = 'right';
            app.TYPEDropDown_13Label.Position = [45 349 65 22];
            app.TYPEDropDown_13Label.Text = 'TYPE';
```

```
            % Create TYPEDropDown_13
            app.TYPEDropDown_13 = uidropdown(app.UIFigure);
            app.TYPEDropDown_13.Items = {'Select', 'CRANK', 'COUPLER', 'ROCKER',
'FIXED LINK', 'COUPLER2', 'OFFSET'};
            app.TYPEDropDown_13.Position = [125 349 81 22];
            app.TYPEDropDown_13.Value = 'Select';

            % Create TYPEDropDown_14Label
            app.TYPEDropDown_14Label = uilabel(app.UIFigure);
            app.TYPEDropDown_14Label.HorizontalAlignment = 'right';
            app.TYPEDropDown_14Label.Position = [41 272 65 22];
            app.TYPEDropDown_14Label.Text = 'TYPE';

            % Create TYPEDropDown_14
            app.TYPEDropDown_14 = uidropdown(app.UIFigure);
            app.TYPEDropDown_14.Items = {'Select', 'CRANK', 'COUPLER', 'ROCKER',
'FIXED LINK', 'COUPLER2', 'OFFSET'};
            app.TYPEDropDown_14.Position = [121 272 81 22];
            app.TYPEDropDown_14.Value = 'Select';

            % Create TYPEDropDown_15Label
            app.TYPEDropDown_15Label = uilabel(app.UIFigure);
            app.TYPEDropDown_15Label.HorizontalAlignment = 'right';
            app.TYPEDropDown_15Label.Position = [35 203 65 22];
            app.TYPEDropDown_15Label.Text = 'TYPE';

            % Create TYPEDropDown_15
            app.TYPEDropDown_15 = uidropdown(app.UIFigure);
            app.TYPEDropDown_15.Items = {'Select', 'CRANK', 'COUPLER', 'ROCKER',
'FIXED LINK', 'COUPLER2', 'OFFSET'};
```

```
            app.TYPEDropDown_15.Position = [115 203 81 22];
            app.TYPEDropDown_15.Value = 'Select';

            % Create TYPEDropDown_16Label
            app.TYPEDropDown_16Label = uilabel(app.UIFigure);
            app.TYPEDropDown_16Label.HorizontalAlignment = 'right';
            app.TYPEDropDown_16Label.Position = [44 131 65 22];
            app.TYPEDropDown_16Label.Text = 'TYPE';

            % Create TYPEDropDown_16
            app.TYPEDropDown_16 = uidropdown(app.UIFigure);
            app.TYPEDropDown_16.Items = {'Select', 'CRANK', 'COUPLER', 'ROCKER',
'FIXED LINK', 'COUPLER2', 'OFFSET'};
            app.TYPEDropDown_16.Position = [124 131 81 22];
            app.TYPEDropDown_16.Value = 'Select';

            % Create TYPEDropDown_17Label
            app.TYPEDropDown_17Label = uilabel(app.UIFigure);
            app.TYPEDropDown_17Label.HorizontalAlignment = 'right';
            app.TYPEDropDown_17Label.Position = [38 69 65 22];
            app.TYPEDropDown_17Label.Text = 'TYPE';

            % Create TYPEDropDown_17
            app.TYPEDropDown_17 = uidropdown(app.UIFigure);
            app.TYPEDropDown_17.Items = {'Select', 'CRANK', 'COUPLER', 'ROCKER',
'FIXED LINK', 'COUPLER2', 'OFFSET'};
            app.TYPEDropDown_17.Position = [118 69 81 22];
            app.TYPEDropDown_17.Value = 'Select';
```

```
% Create asEditFieldLabel
app.asEditFieldLabel = uilabel(app.UIFigure);
app.asEditFieldLabel.HorizontalAlignment = 'right';
app.asEditFieldLabel.Position = [276 142 25 22];
app.asEditFieldLabel.Text = 'as';

% Create asEditField
app.asEditField = uieditfield(app.UIFigure, 'numeric');
app.asEditField.Position = [306 139 20 27];

% Create bsEditFieldLabel
app.bsEditFieldLabel = uilabel(app.UIFigure);
app.bsEditFieldLabel.HorizontalAlignment = 'right';
app.bsEditFieldLabel.Position = [277 104 25 22];
app.bsEditFieldLabel.Text = 'bs';

% Create bsEditField
app.bsEditField = uieditfield(app.UIFigure, 'numeric');
app.bsEditField.Position = [306 101 21 27];

% Create csEditFieldLabel
app.csEditFieldLabel = uilabel(app.UIFigure);
app.csEditFieldLabel.HorizontalAlignment = 'right';
app.csEditFieldLabel.Position = [277 72 25 22];
app.csEditFieldLabel.Text = 'cs';

% Create csEditField
app.csEditField = uieditfield(app.UIFigure, 'numeric');
```

```
app.csEditField.Position = [306 69 21 27];

% Create crsEditFieldLabel
app.crsEditFieldLabel = uilabel(app.UIFigure);
app.crsEditFieldLabel.HorizontalAlignment = 'right';
app.crsEditFieldLabel.Position = [276 38 25 22];
app.crsEditFieldLabel.Text = 'crs';

% Create crsEditField
app.crsEditField = uieditfield(app.UIFigure, 'numeric');
app.crsEditField.Position = [306 35 20 27];

% Create FasEditFieldLabel
app.FasEditFieldLabel = uilabel(app.UIFigure);
app.FasEditFieldLabel.HorizontalAlignment = 'right';
app.FasEditFieldLabel.Position = [339 142 26 22];
app.FasEditFieldLabel.Text = 'Fas';

% Create FasEditField
app.FasEditField = uieditfield(app.UIFigure, 'numeric');
app.FasEditField.Position = [367 139 23 27];

% Create FbsEditFieldLabel
app.FbsEditFieldLabel = uilabel(app.UIFigure);
app.FbsEditFieldLabel.HorizontalAlignment = 'right';
app.FbsEditFieldLabel.Position = [339 116 26 22];
app.FbsEditFieldLabel.Text = 'Fbs';
```

```
% Create FbsEditField
app.FbsEditField = uieditfield(app.UIFigure, 'numeric');
app.FbsEditField.Position = [367 113 23 27];

% Create FcsEditFieldLabel
app.FcsEditFieldLabel = uilabel(app.UIFigure);
app.FcsEditFieldLabel.HorizontalAlignment = 'right';
app.FcsEditFieldLabel.Position = [340 94 25 22];
app.FcsEditFieldLabel.Text = 'Fcs';

% Create FcsEditField
app.FcsEditField = uieditfield(app.UIFigure, 'numeric');
app.FcsEditField.Position = [367 91 23 27];

% Create FcrsEditFieldLabel
app.FcrsEditFieldLabel = uilabel(app.UIFigure);
app.FcrsEditFieldLabel.HorizontalAlignment = 'right';
app.FcrsEditFieldLabel.Position = [335 64 29 22];
app.FcrsEditFieldLabel.Text = 'Fcrs';

% Create FcrsEditField
app.FcrsEditField = uieditfield(app.UIFigure, 'numeric');
app.FcrsEditField.Position = [367 61 22 27];

% Create FssEditFieldLabel
app.FssEditFieldLabel = uilabel(app.UIFigure);
app.FssEditFieldLabel.HorizontalAlignment = 'right';
app.FssEditFieldLabel.Position = [339 38 25 22];
```

```
app.FssEditFieldLabel.Text = 'Fss';

% Create FssEditField
app.FssEditField = uieditfield(app.UIFigure, 'numeric');
app.FssEditField.Position = [367 35 22 27];

% Create thetaFasEditFieldLabel
app.thetaFasEditFieldLabel = uilabel(app.UIFigure);
app.thetaFasEditFieldLabel.HorizontalAlignment = 'right';
app.thetaFasEditFieldLabel.Position = [400 142 52 22];
app.thetaFasEditFieldLabel.Text = 'thetaFas';

% Create thetaFasEditField
app.thetaFasEditField = uieditfield(app.UIFigure, 'numeric');
app.thetaFasEditField.Position = [451 139 26 27];

% Create thetaFbsEditFieldLabel
app.thetaFbsEditFieldLabel = uilabel(app.UIFigure);
app.thetaFbsEditFieldLabel.HorizontalAlignment = 'right';
app.thetaFbsEditFieldLabel.Position = [400 116 52 22];
app.thetaFbsEditFieldLabel.Text = 'thetaFbs';

% Create thetaFbsEditField
app.thetaFbsEditField = uieditfield(app.UIFigure, 'numeric');
app.thetaFbsEditField.Position = [453 113 24 27];

% Create thetaFcsEditFieldLabel
app.thetaFcsEditFieldLabel = uilabel(app.UIFigure);
```

```
app.thetaFcsEditFieldLabel.HorizontalAlignment = 'right';
app.thetaFcsEditFieldLabel.Position = [401 90 51 22];
app.thetaFcsEditFieldLabel.Text = 'thetaFcs';

% Create thetaFcsEditField
app.thetaFcsEditField = uieditfield(app.UIFigure, 'numeric');
app.thetaFcsEditField.Position = [453 87 24 27];

% Create thetaFcrsEditFieldLabel
app.thetaFcrsEditFieldLabel = uilabel(app.UIFigure);
app.thetaFcrsEditFieldLabel.HorizontalAlignment = 'right';
app.thetaFcrsEditFieldLabel.Position = [397 64 55 22];
app.thetaFcrsEditFieldLabel.Text = 'thetaFcrs';

% Create thetaFcrsEditField
app.thetaFcrsEditField = uieditfield(app.UIFigure, 'numeric');
app.thetaFcrsEditField.Position = [451 61 26 27];

% Create thetaFssEditFieldLabel
app.thetaFssEditFieldLabel = uilabel(app.UIFigure);
app.thetaFssEditFieldLabel.HorizontalAlignment = 'right';
app.thetaFssEditFieldLabel.Position = [401 38 51 22];
app.thetaFssEditFieldLabel.Text = 'thetaFss';

% Create thetaFssEditField
app.thetaFssEditField = uieditfield(app.UIFigure, 'numeric');
app.thetaFssEditField.Position = [453 35 24 27];
```

```
            % Show the figure after all components are created
            app.UIFigure.Visible = 'on';
        end
    end
    % App creation and deletion
    methods (Access = public)

        % Construct app
        function app = Variable_stroke_mechanism_t2_exported
            % Create UIFigure and components
            createComponents(app)

            % Register the app with App Designer
            registerApp(app, app.UIFigure)

            if nargout == 0
                clear app
            end
        end

        % Code that executes before app deletion
        function delete(app)

            % Delete UIFigure when app is deleted
            delete(app.UIFigure)
        end
    end
end
```

APPENDIX:

https://in.mathworks.com/

http://mechdesigner.support/md-kinematics-grashoff-criterion.html