

19PHY104: Course Project (End-Sem) Team No. 11

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BTech CS-AI First Semester

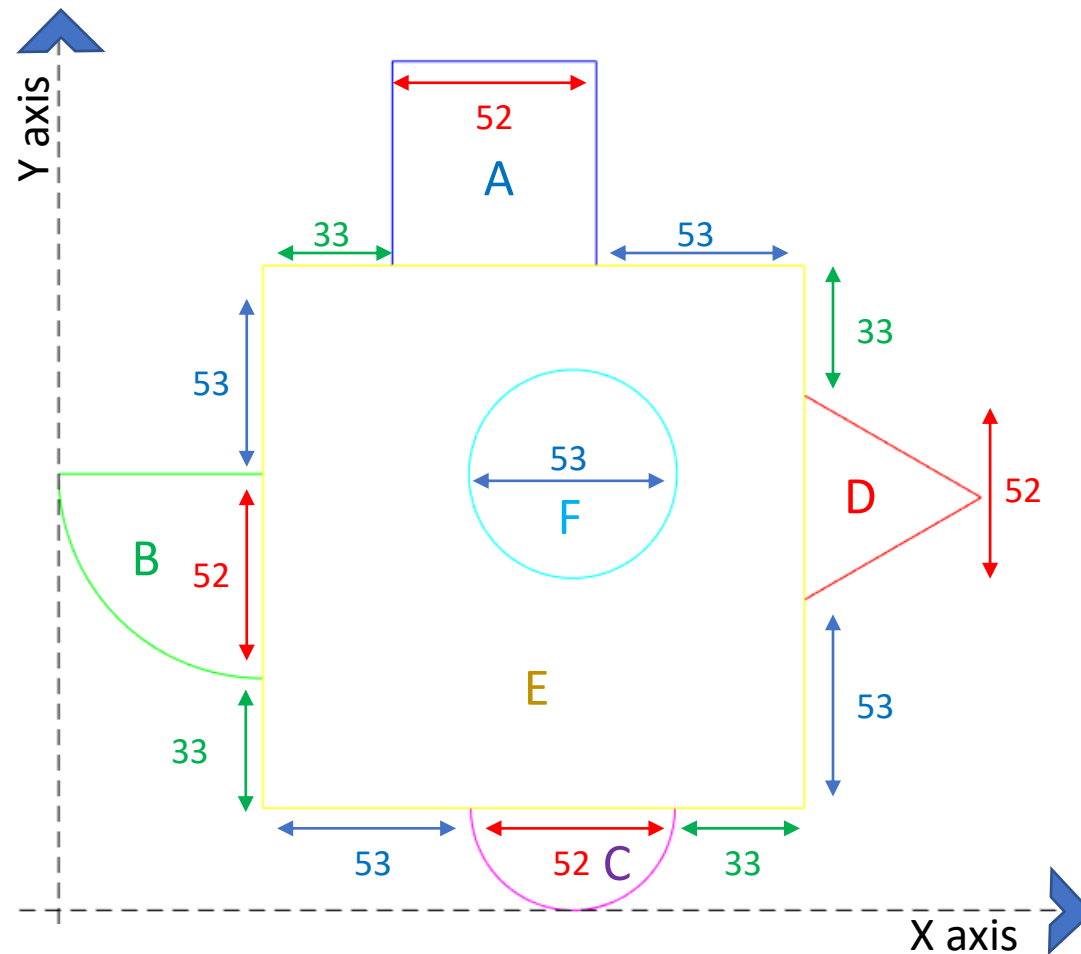
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Question

- For Team 11 we have $a=53$, $b=52$ and $c=33$. $r = (11\%3)+1 = 3$



Centroid

Figure/ Area Fi	xi	yi	Ai	xiAi	yiAi
A (Small square)	111	190	2704	300144	513760
B (Quarter Circle)	29.93051	88.93051	2123.716634	63563.93	188863.2
C (Semicircle)	131	14.96526	1061.858317	139103.4	15890.98
D (Triangle)	205.01	105	1170.87	240040.1	122941.4
E (Large square)	121	95	19044	2304324	1809180
F (Cut out Circle)	131	111	-2206.18344	-289010	-244886
Total			23898.26151	2758165	2405749

Centroid of composite figure:

$$X = \frac{\sum(x_i A_i)}{\sum(A_i)} = \underline{\underline{115.4128}}$$

$$Y = \frac{\sum(y_i A_i)}{\sum(A_i)} = \underline{\underline{100.6663}}$$

Centroid

Red star: Centroid of Composite area
Coordinates: G(115.4128, 100.6663)

Coordinates: A(111, 190)

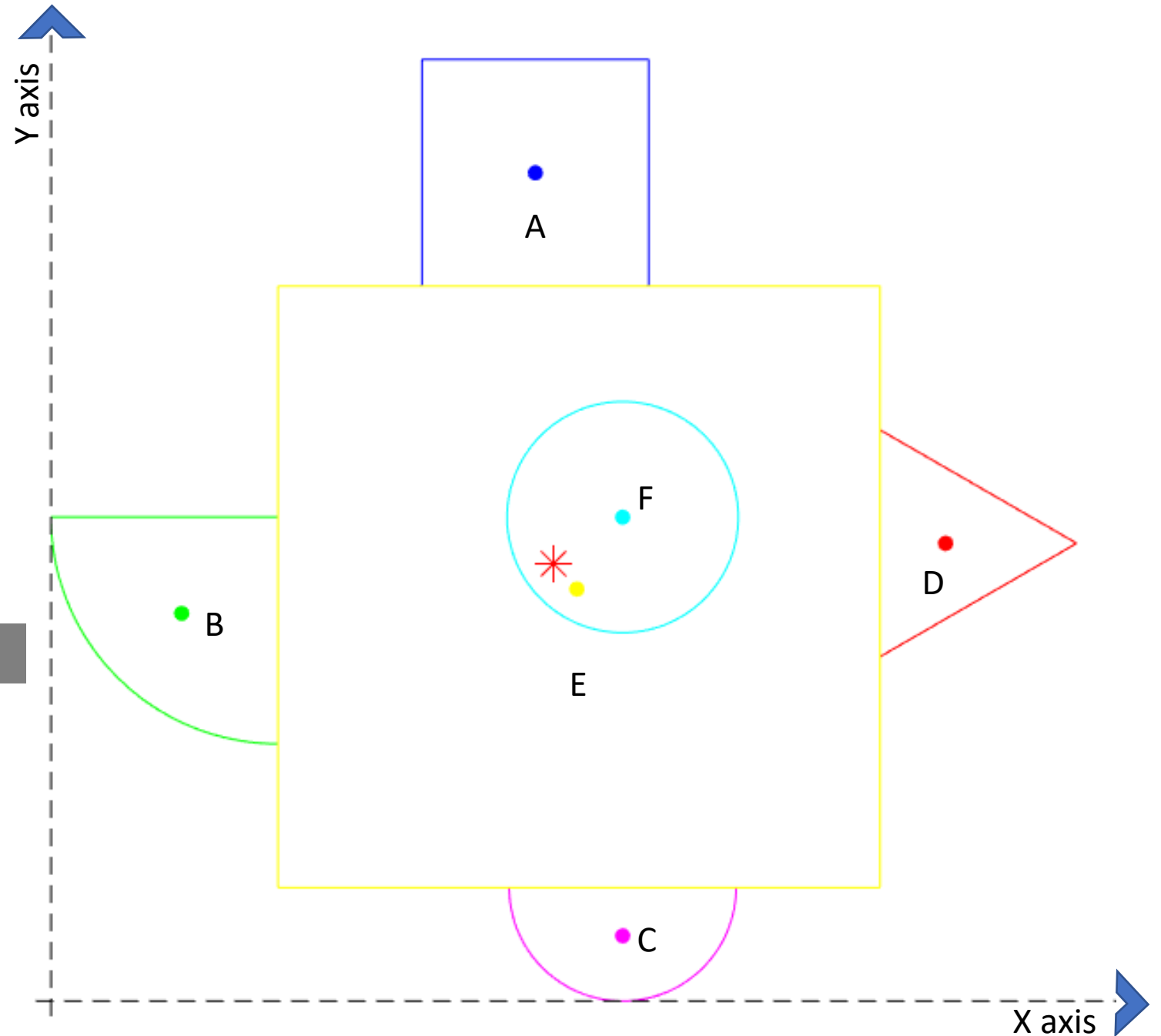
Coordinates: B(299.93051, 88.93051)

Coordinates: C(131,14.96526)

Coordinates: D(205.01, 105)

Coordinates: E(121,95)

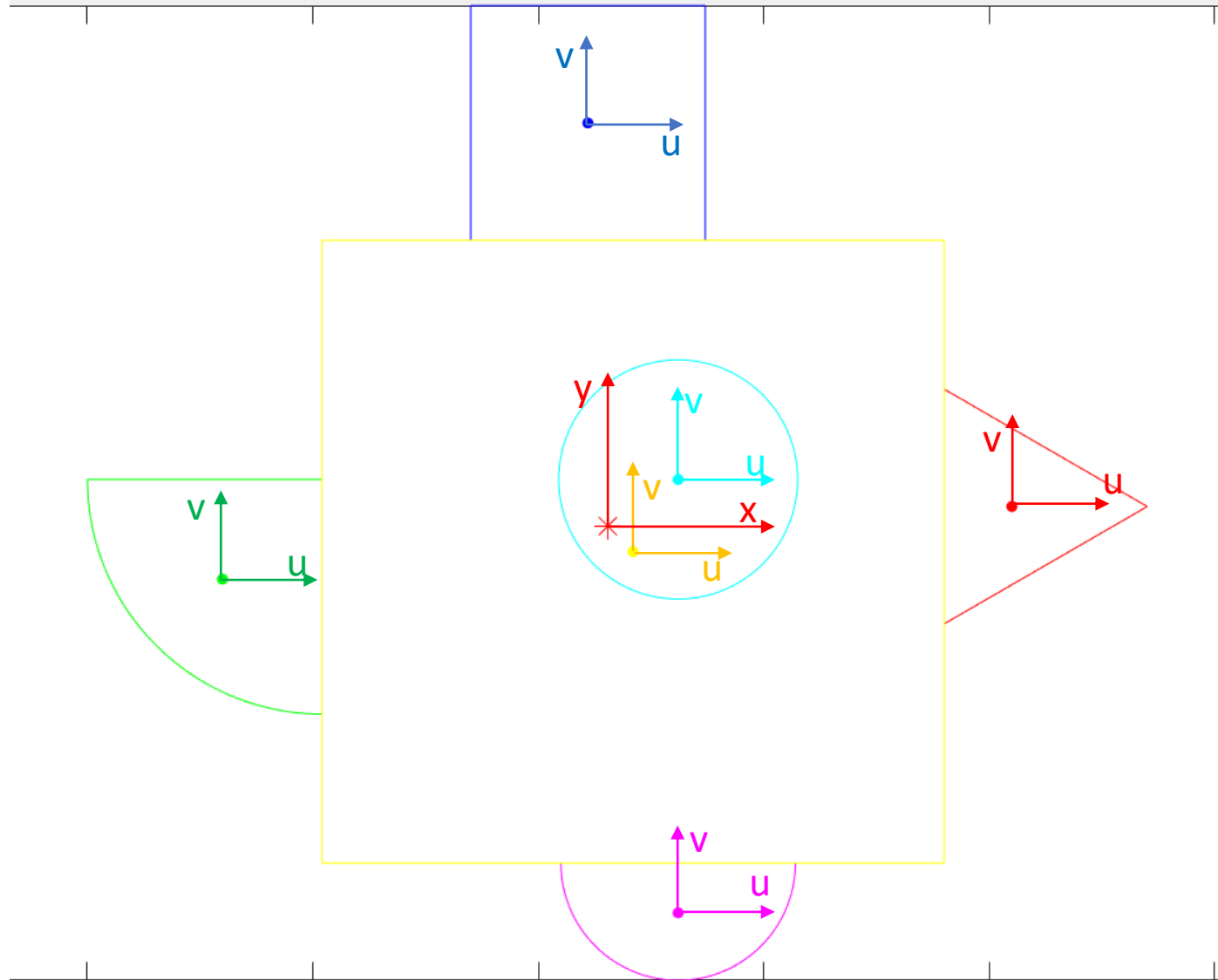
Coordinates: F(131,111)



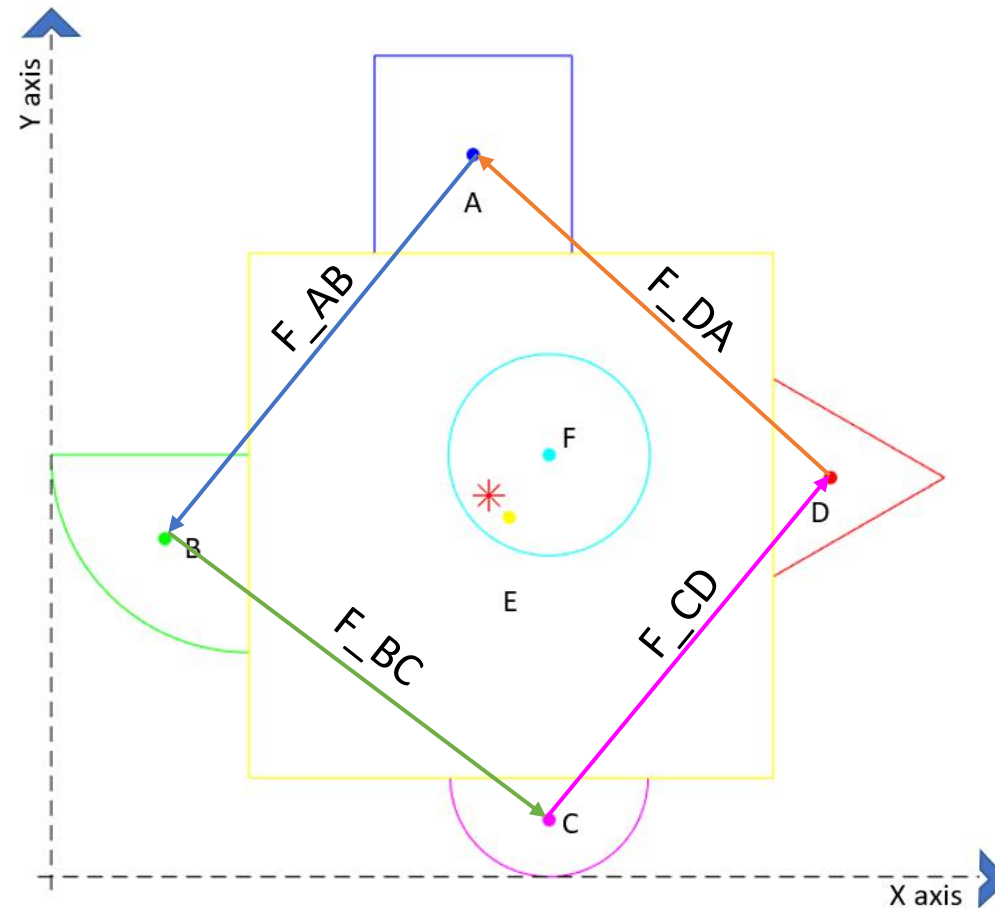
Moment of Inertia (Area)

Figure/ Area Fi	dx _i	dy _i	I _{ui}	I _{vi}	I _{xi}	I _{yi}
A (Small square)	4.412805	89.33372	609301.33	609301.33	22188608	661955.9
B (Quarter Circle)	85.48229059	11.7357696	401261.48	401261.48	693757.3363	7849171
C (Semicircle)	15.58719	85.70103	50175.96	179363.08	7849171	437352
D (Triangle)	4.333716	4.333716	131907.88	131888.42	153898.1	153878.6
E (Large square)	5.587195	5.666284	30222828	30222828	30834269	30817320
F (Cut out Circle)	15.58719	10.33372	387126.72	387126.72	-622716	-923142
Total (MOI)				I_x = 61096988		I_y = 47067095

Moment of Inertia (Area)



Resultant Force on Rigid Body



Resultant Force on Rigid Body

$F_{ab}=F_b-F_a$	$F_{bc}=F_c-F_b$	$F_{cd}=F_d-F_c$	$F_{da}=F_a-F_d$	Resultant
-81.06948544	101.0694854	74.01	-94.01	0
-101.0694854	-73.96525728	90.03474272	85	0

Resultant Moment on Rigid Body about Centroid

	R	F
AB		
x	-4.412805151	-81.06948545
y	89.33371584	-101.0694854
BC		
x	-85.48229059	101.0694855
y	-11.7357696	-73.96525725

	R	F
CD		
x	15.58719485	74.01000133
y	-85.70102688	90.03474163
DA		
x	89.59719485	-94.01
y	4.333715844	85

M_AB	M_BC	M_CD	M_DA	Total moment about centroid
7688.238322	7508.847809	7746.122174	8023.17418874444	30966.38249

The moment about centroid due to the forces is 30966.38249 Nm

The body rotates in an anti-clockwise direction due to the forces

Excel Link

All calculations in the above problems have been done with the help of excel.





R and F were also obtained from excel

The cross product of R and F has been calculated separately and then values were entered

The link for excel:

[Excel](#)

Kinematics of Particle

- We have animated the route: A  C  B  D  A.
- We have taken extra points A_mid, C_mid where line from A to C touches and leaves the circle, respectively.
- We have also taken B_mid, D_mid where line from B to D touches and leaves the circle, respectively.

Kinematics of Particle

Figure of the particle after completing full motion (MATLAB)

- Total distance travelled:

A → A_mid=75.1082 units

A_mid → C_mid= 13.8754 units

C_mid → C=90.0098 units

C → B=125.2466 units

B → B_mid=99.7798 units

B_mid → D_mid=10.1753 units

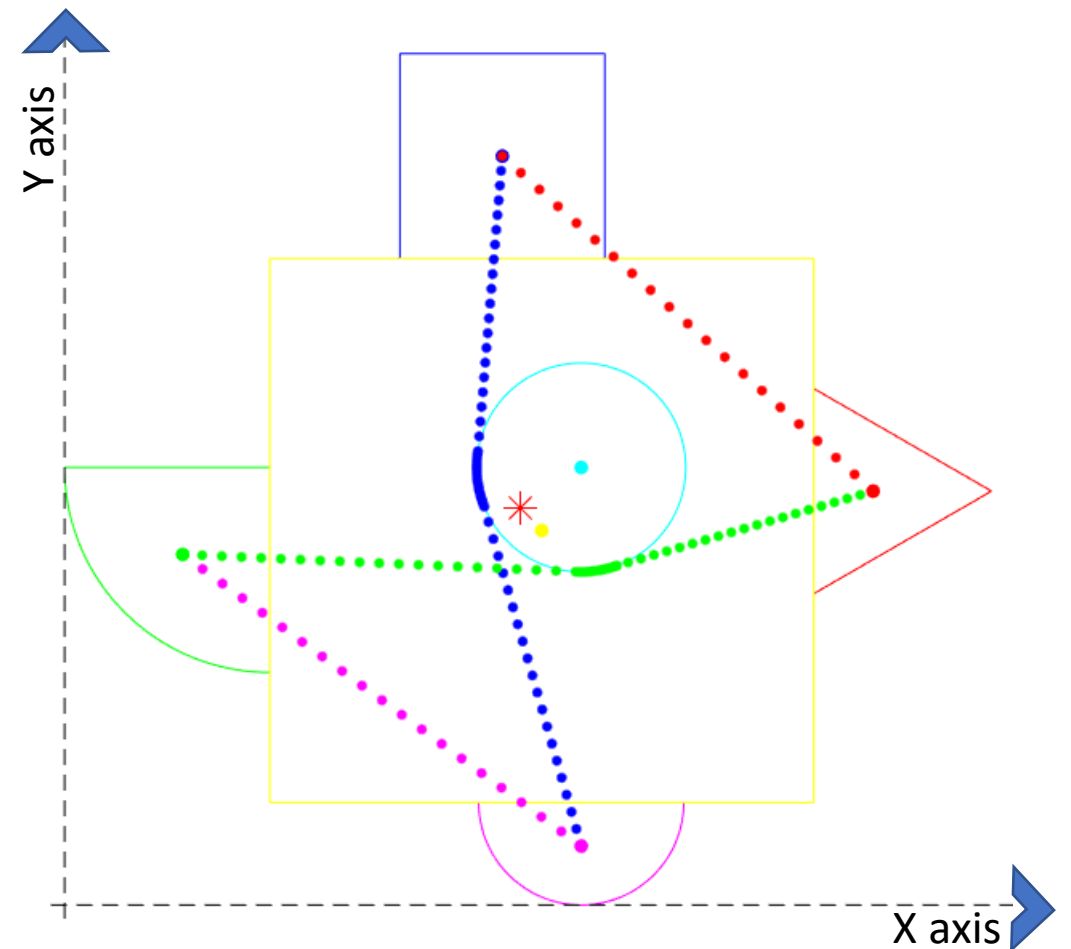
D_mid → D=68.1025 units

D → A=126.7394 units

Total= 610.9754 units

```
%Total distance
```

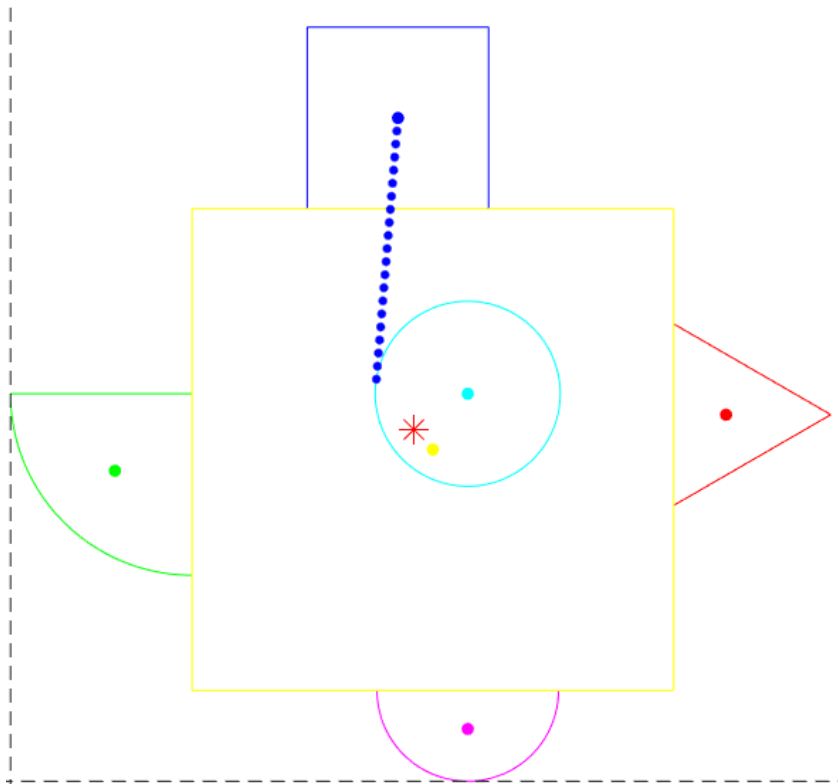
```
Distance=Dist_AtoA_mid+Dist_A_midtoC_mid+Dist_C_midtoC+Dist_CtoB+....  
Dist_BtoB_mid+Dist_B_midtoD_mid+Dist_D_midtoD+Dist_DtoA;
```



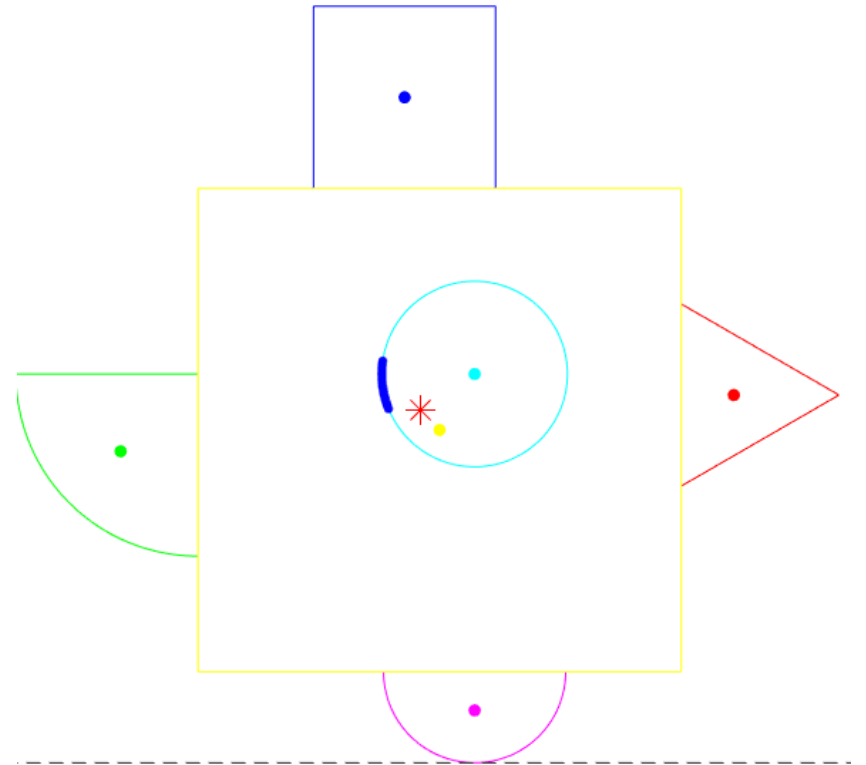
Kinematics of Particle

- Motion between these:

$A \rightarrow A_{\text{mid}}$ is linear



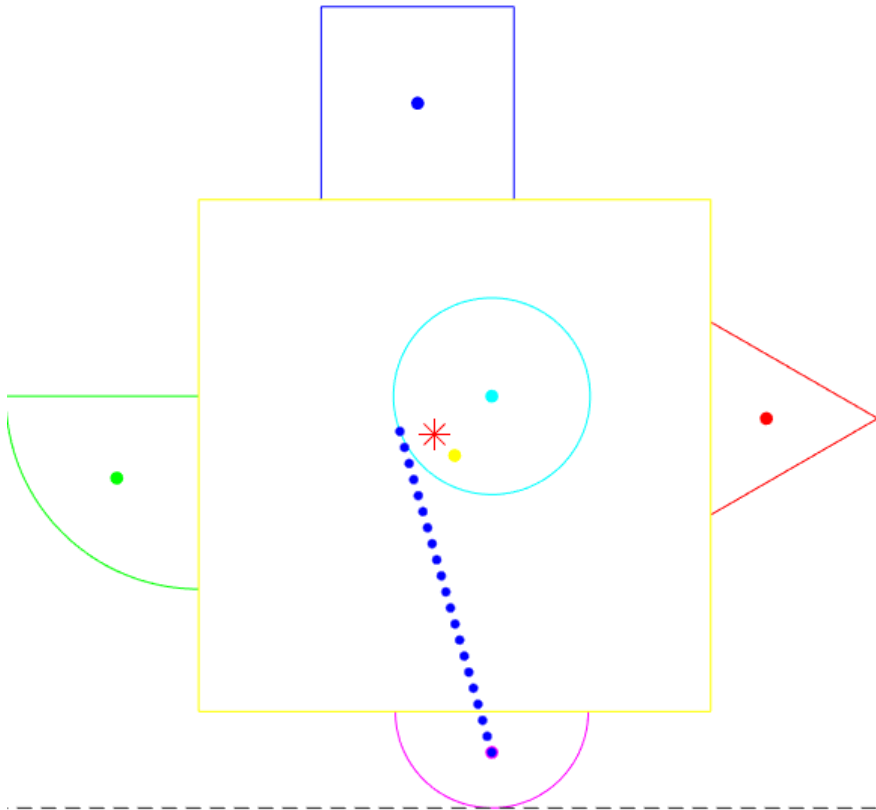
$A_{\text{mid}} \rightarrow C_{\text{mid}}$ is circular



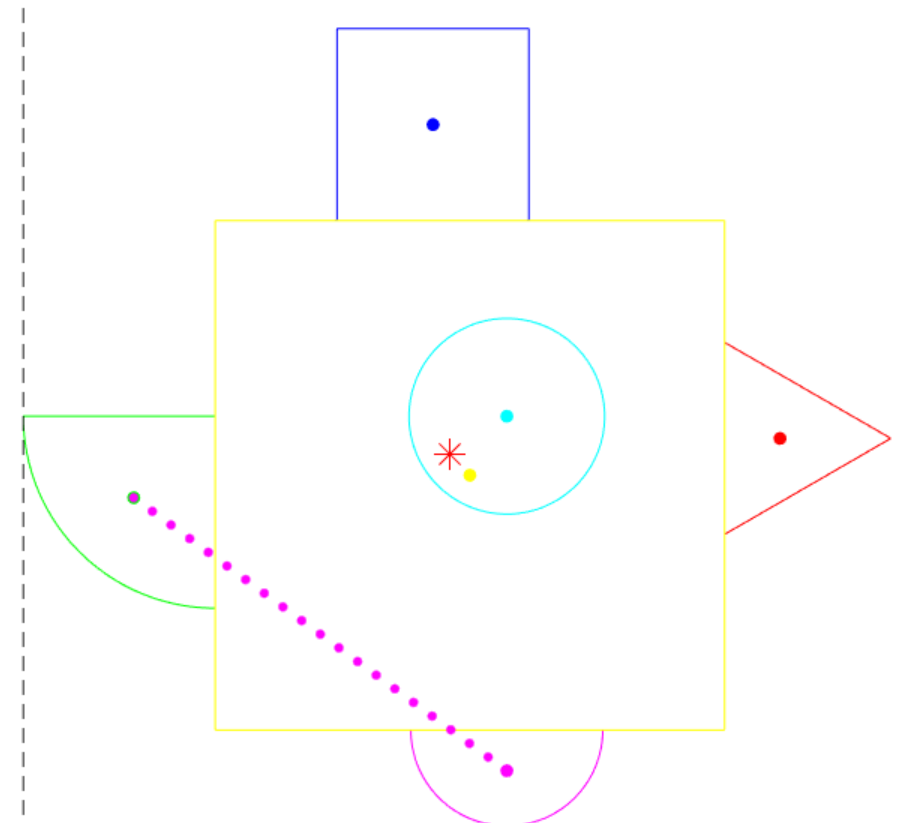
Kinematics of Particle

- Motion between these:

C mid \rightarrow C is linear



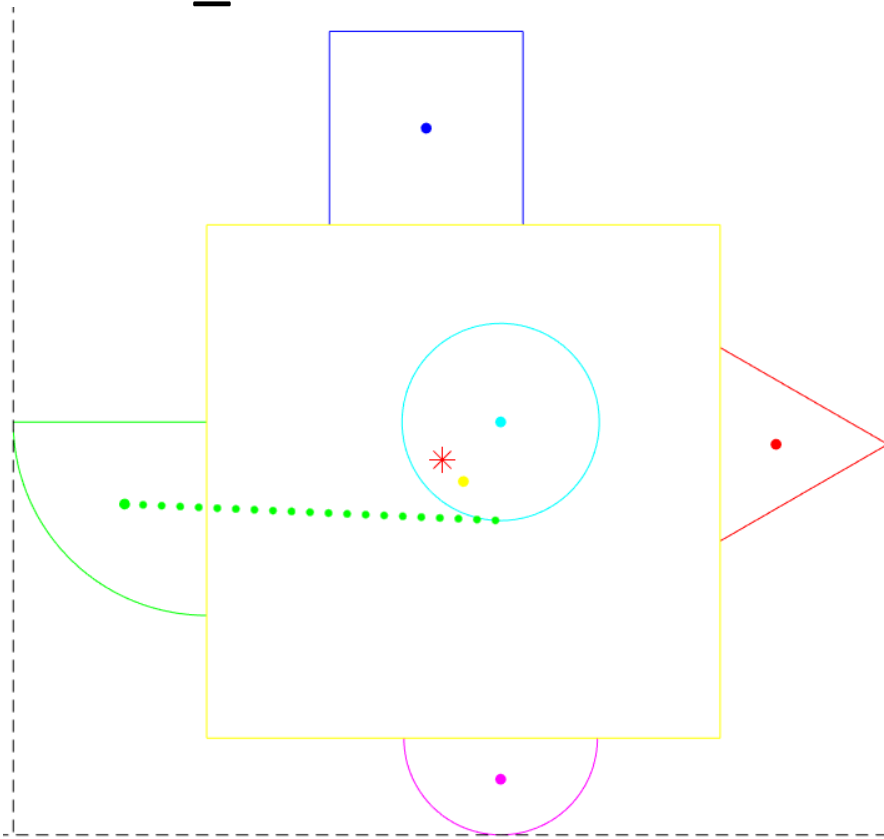
C \rightarrow B is linear



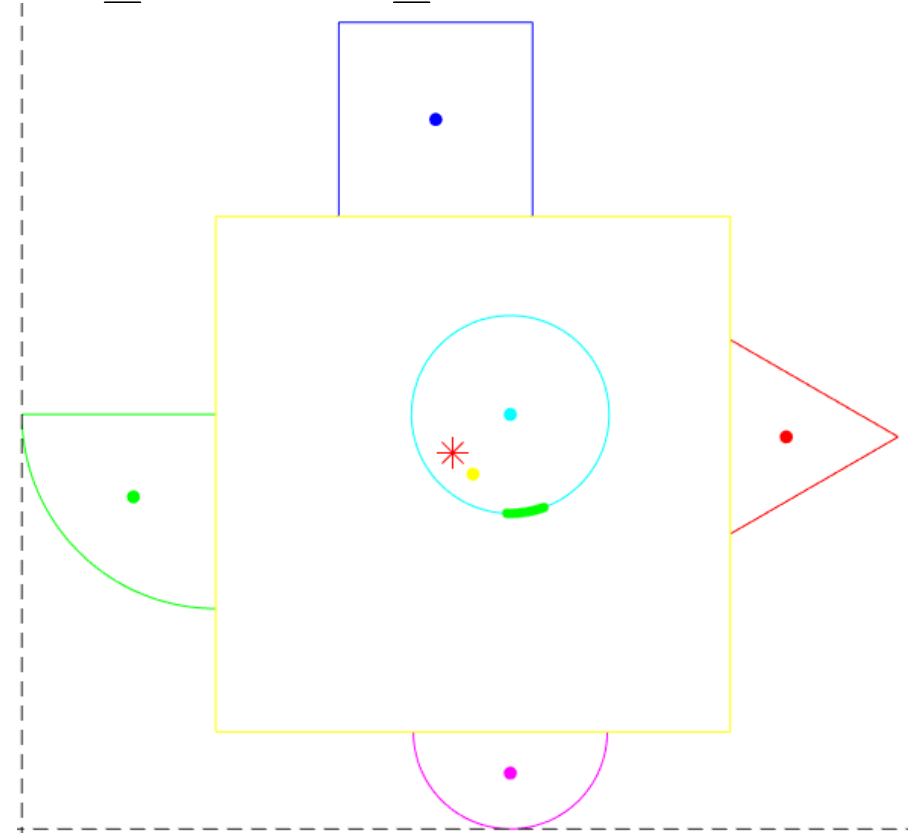
Kinematics of Particle

- Motion between these:

$B \rightarrow B_{\text{mid}}$ is linear



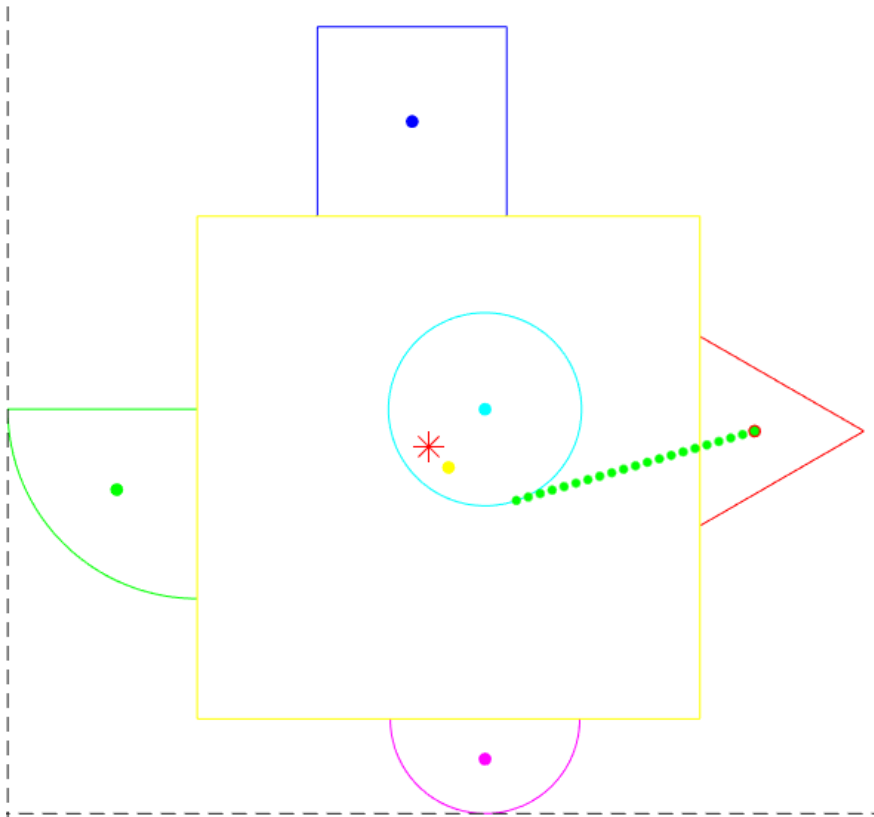
$B_{\text{mid}} \rightarrow D_{\text{mid}}$ is circular



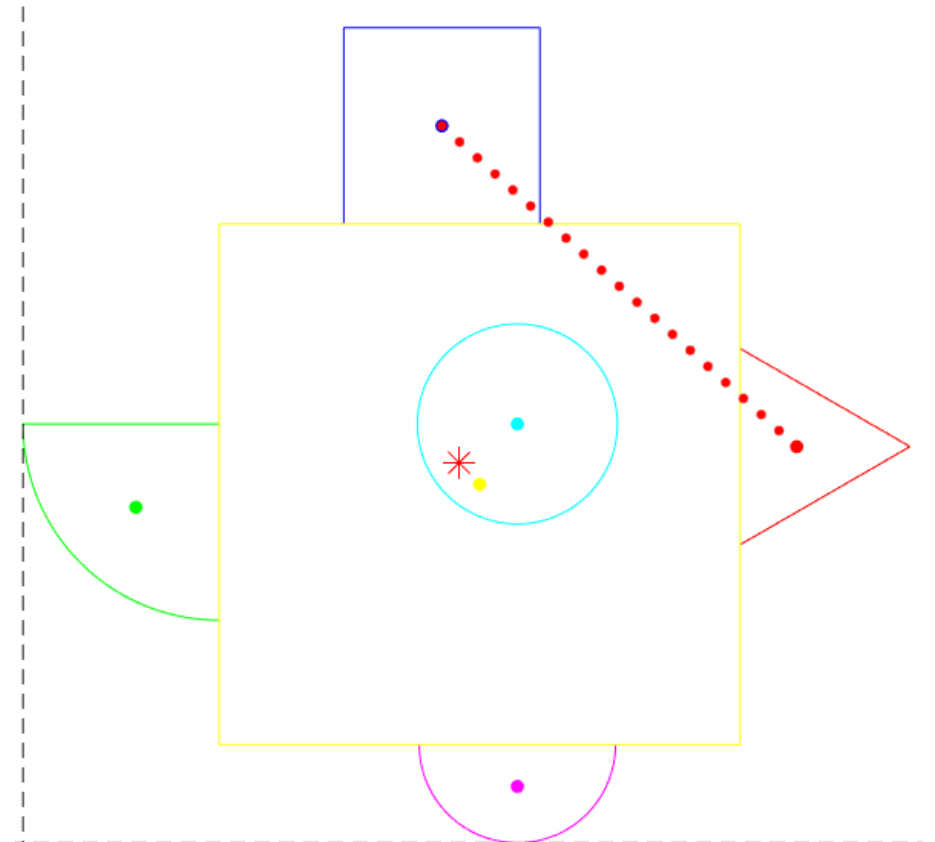
Kinematics of Particle

- Motion between these:

$D_{\text{mid}} \rightarrow D$ is linear



$D \rightarrow A$ is linear



Kinematics of Particle

```
Editor - C:\Users\angel\OneDrive\Documents\MATLAB\maths\physics\Phy proj\Phy_proj_Anima
Phy_proj_Animation.m x +
1 -   clc;clear all;clf;
2
3   % Let us plot all the figures
4   %Shape A: Small square with side 52 units
5   %Centroid of A
6   Ac=[111 190];
7   plot(Ac(1), Ac(2), 'b.', 'MarkerSize',18);
8   hold on;
9   %Shape A plot
10  x_ofA=[85 85 137 137 85];
11  y_ofA=[164 216 216 164 164];
12  plot(x_ofA,y_ofA, 'b');
13  hold on;
14
15  %Shape B: Quarter circle with radius 52
16  r_B=52;
17  Center_B_circle=[52, 111];
18  angle_B= 180:1:270
19  %Centroid of B
20  Bc=[29.93 88.93];
21  plot(Bc(1), Bc(2), 'g.', 'MarkerSize',18);
22  hold on;
23  %Shape B plot
24  x_ofB = Center_B_circle(1)+r_B*cosd(angle_B) ;
25  y_ofB = Center_B_circle(2)+r_B*sind(angle_B) ;
26  plot(x_ofB ,y_ofB, 'g');
27  plot([0 52], [111 111], 'g');
28  plot([52 52], [111 59], 'g');
29  hold on;
```

MATLAB Program:

```
%Shape C: Semicircle with radius 26
r_C=26;
Center_C_circle=[131,26];
angle_C= 180:1:360;
%Centroid of C
Cc=[131 14.96];
plot(Cc(1), Cc(2), 'm.', 'MarkerSize',18);
hold on;
%Shape C plot
x_ofC = Center_C_circle(1)+r_C*cosd(angle_C) ;
y_ofC = Center_C_circle(2)+r_C*sind(angle_C) ;
plot(x_ofC ,y_ofC, 'm');
plot([105 157], [26 26], 'm');
hold on;

%Shape D: Triangle with base 52 and height 45.03
%Centroid of D
Dc=[205.01 105];
plot(Dc(1), Dc(2), 'r.', 'MarkerSize',18);
hold on;
%Shape D plot
x_ofD=[190 235.03 190 190];
y_ofD=[131 105 79 131];
plot(x_ofD,y_ofD, 'r');
hold on;
```

Kinematics of Particle

```
%Shape E: Main square with side 138 units
%Centroid of E
Ec=[121 95];
plot(Ec(1), Ec(2), 'y.', 'MarkerSize', 18);
hold on;
%Shape E plot
x_ofE=[52 52 190 190 52];
y_ofE=[26 164 164 26 26];
plot(x_ofE, y_ofE, 'y');
hold on;

%Shape F: Circle cut out with radius 26.5
r_F=26.5;
Center_F_circle=[131, 111];
angle_F= 0:1:360;
%Centroid of F
Fc=[131 111];
plot(Fc(1), Fc(2), 'c.', 'MarkerSize', 18);
hold on;
%Shape F plot
x_ofF = Center_F_circle(1)+r_F*cosd(angle_F) ;
y_ofF = Center_F_circle(2)+r_F*sind(angle_F) ;
plot(x_ofF, y_ofF, 'c');
hold on;
```

MATLAB Program :

```
%Now let us draw the x and y axis
plot([-10 300] , [0 0] , 'k--');
hold on;
plot([0 0] , [-10 300] , 'k--');
hold on;
axis equal;

%Now we plot centroid G of composite area
Gc=[115.4128, 100.6663];
plot(Gc(1), Gc(2), 'r*', 'MarkerSize', 12);
hold on;
```

Kinematics of Particle

MATLAB Program :

```
%Now we animate the route
%A-->C-->B-->D-->A

%for A-->C
Ac=[111 190];
A_mid=[104.826 115.146];
C_mid=[106.26 101.503];
Cc=[131 14.96];
for lamda=0:0.05:1
    x=(1-lamda)*Ac+lamda*A_mid;
    plot(x(1,1),x(1,2),'b.', 'MarkerSize', 12) % plots one point
    pause(0.05);
    hold on
    axis('equal') % command to take equal distribution of points in X and Y axis
    drawnow
end
%Distance A to A_mid
Dist_AtoA_mid=sqrt(((A_mid(1)-Ac(1))^2)+((A_mid(2)-Ac(2))^2));
```

Kinematics of Particle

MATLAB Program :

```
A_mid_angle=172;
C_mid_angle=202;
AngleAC=C_mid_angle-A_mid_angle;
ThetaArray = linspace((A_mid_angle*pi)/180,(C_mid_angle*pi)/180,180);
LengthOfThetaArray = length(ThetaArray);
r_F=26.5;
%For moving outside the circle
for index = 1:1:LengthOfThetaArray
    theta = ThetaArray(index);
    x = Fc(1)+r_F*cos(theta);
    y = Fc(2)+r_F*sin(theta);
    plot(x, y, 'b.', 'MarkerSize', 12);
    drawnow;
    pause(0);
end
%Distance A_mid to C_mid
Dist_A_midtoC_mid=r_F*((AngleAC*pi)/180);
```

Kinematics of Particle

MATLAB Program :

```
for lamda=0:0.05:1
    x=(1-lamda)*C_mid+lamda*Cc;
    plot(x(1,1),x(1,2),'b.', 'MarkerSize', 12) % plots one point
    pause(0.05);
    hold on
    axis('equal') % command to take equal distribution of points in X and Y axis
    drawnow
end
%Distance C_mid to C
Dist_C_midtoC=sqrt((((Cc(1)-C_mid(1))^2)+((Cc(2)-C_mid(2))^2)));
```

Kinematics of Particle

MATLAB Program :

```
%for C-->B
Cc=[131 14.96];
Bc=[29.93 88.93];
for lamda=0:0.05:1
    x=(1-lamda)*Cc+lamda*Bc;
    plot(x(1,1),x(1,2),'m.', 'MarkerSize', 12) % plots one point
    pause(0.05);
    hold on
    axis('equal') % command to take equal distribution of points in X and Y axis
    drawnow
end
%Distance C to B
Dist_CtoB=sqrt(((Bc(1)-Cc(1))^2)+((Bc(2)-Cc(2))^2));
```

Kinematics of Particle

MATLAB Program :

```
%for B-->D
Bc=[29.93 88.93];
B_mid=[129.613 84.5363];
D_mid=[139.628 85.9438];
Dc=[205.01 105];
for lamda=0:0.05:1
    x=(1-lamda)*Bc+lamda*B_mid;
    plot(x(1,1),x(1,2),'g.', 'MarkerSize', 12) % plots one point
    pause(0.05);
    hold on
    axis('equal') % command to take equal distribution of points in X and Y axis
    drawnow
end
%Distance B to B_mid
Dist_BtoB_mid=sqrt((((B_mid(1)-Bc(1))^2)+((B_mid(2)-Bc(2))^2)));
```

Kinematics of Particle

MATLAB Program :

```
B_mid_angle=268;
D_mid_angle=290;
AngleBD=D_mid_angle-B_mid_angle;
ThetaArray = linspace((B_mid_angle*pi)/180,(D_mid_angle*pi)/180,180);
LengthOfThetaArray = length(ThetaArray);
r_F=26.5;
%For moving outside the circle
for index = 1:1:LengthOfThetaArray
    theta = ThetaArray(index);
    x = Fc(1)+r_F*cos(theta);
    y = Fc(2)+r_F*sin(theta);
    plot(x, y, 'g.','MarkerSize', 12);
    drawnow;
    pause(0);
end
%Distance B_mid to D_mid
Dist_B_midtoD_mid=r_F*((AngleBD*pi)/180);
```


Kinematics of Particle

MATLAB Program :

```
for lamda=0:0.05:1
    x=(1-lamda)*D_mid+lamda*Dc;
    plot(x(1,1),x(1,2),'g.', 'MarkerSize', 12) % plots one point
    pause(0.05);
    hold on
    axis('equal') % command to take equal distribution of points in X and Y axis
    drawnow
end
%Distance D_mid to D
Dist_D_midtoD=sqrt(((Dc(1)-D_mid(1))^2)+((Dc(2)-D_mid(2))^2));
```

Kinematics of Particle

MATLAB Program :

```
%for D-->A
Dc=[205.01 105];
Ac=[111 190];
for lamda=0:0.05:1
    x=(1-lamda)*Dc+lamda*Ac;
    plot(x(1,1),x(1,2),'r.', 'MarkerSize', 12) % plots one point
    pause(0.05);
    hold on
    axis('equal') % command to take equal distribution of points in X and Y axis
    drawnow
end
%Distance D to A
Dist_DtoA=sqrt(((Dc(1)-Ac(1))^2)+((Dc(2)-Ac(2))^2));
```