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## Clear Workspace

```
close all;  
clear;  
clc;
```

## Given Data

```
m = 1637; % kg  
Iz = 3326; % kg-m^2  
l = 2.736; % m  
t = 1.7; % m  
a = 0.4*1; % 60% front load distribution  
b = 0.6*1; % 60% front load distribution  
Cf = 1500*(180/pi); % N/rad  
Cr = 1146*(180/pi); % N/rad  
G = 15;  
h = 2.4/3.281; % m
```

## Maneuver 1

```
v = 74/2.237; % m/s  
  
% System matrix A  
A = [ -((Cf+Cr)/(m*v)) ((Cr*b-Cf*a)/(m*v^2)-1);  
      (Cr*b-Cf*a)/Iz      -((Cr*b^2+Cf*a^2)/(Iz*v)) ];  
  
% Control matrix B  
B = [ Cf/(m*v); (Cf*a)/Iz ];  
  
% Simulation parameters  
dt = 0.001; % s  
X(:,1) = [0;0];  
Xdot = [];  
Xint(:,1) = [0;0];  
V = [];  
P = [0;0];  
j = 1;  
  
% Simulate from t=0 to t=7  
U = 0; % Control input (@ 0 deg steering wheel angle)  
for i = 0+dt:dt:7  
    Xdot(:,j) = A*X(:,j)+B*U;
```

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X(:,j+1) = X(:,j) + Xdot(:,j)*dt;
Xint(:,j+1) = Xint(:,j) + X(:,j)*dt;
V(:,j) = [v*cos(X(1,j)+Xint(2,j)); v*sin(X(1,j)+Xint(2,j))];
P(:,j+1) = P(:,j) + V(:,j)*dt;
j = j+1;
end

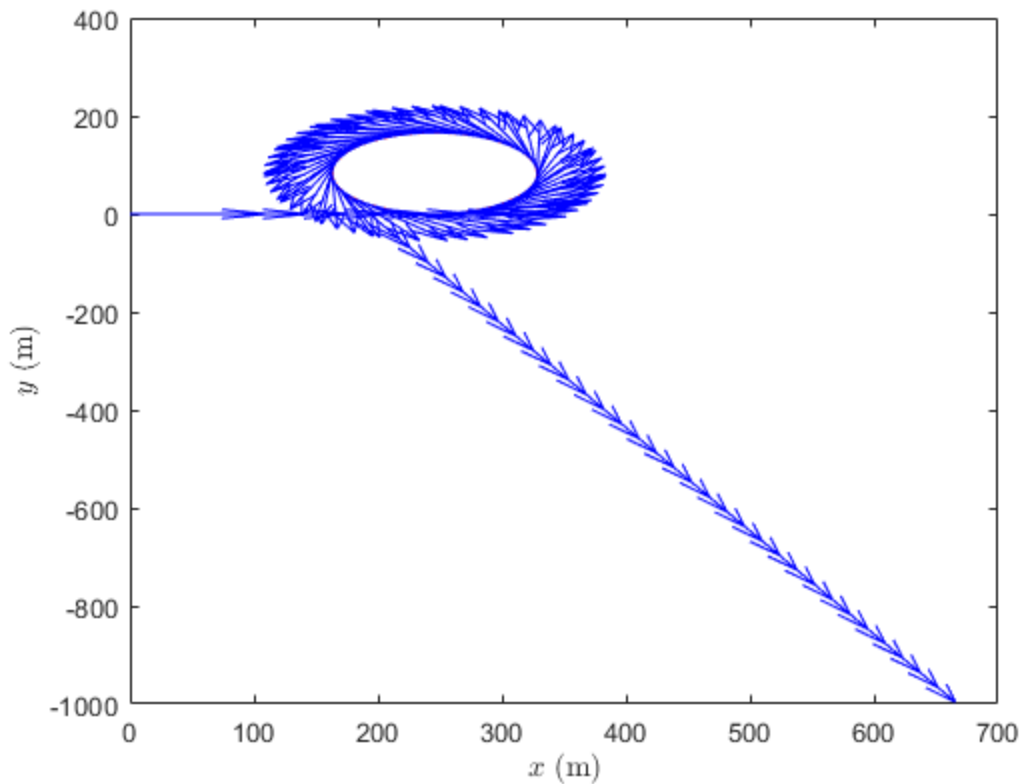
% Simulate from t=7 to t=67
U = (45*(pi/180))/G; % Control input (@ 45 deg steering wheel angle)
for i = 7+dt:dt:67
    Xdot(:,j) = A*X(:,j)+B*U;
    X(:,j+1) = X(:,j) + Xdot(:,j)*dt;
    Xint(:,j+1) = Xint(:,j) + X(:,j)*dt;
    V(:,j) = [v*cos(X(1,j)+Xint(2,j)); v*sin(X(1,j)+Xint(2,j))];
    P(:,j+1) = P(:,j) + V(:,j)*dt;
    j = j+1;
end

% Simulate from t=67 to t=100
U = 0; % Control input (@ 0 deg steering wheel angle)
for i = 67+dt:dt:100
    Xdot(:,j) = A*X(:,j)+B*U;
    X(:,j+1) = X(:,j) + Xdot(:,j)*dt;
    Xint(:,j+1) = Xint(:,j) + X(:,j)*dt;
    V(:,j) = [v*cos(X(1,j)+Xint(2,j)); v*sin(X(1,j)+Xint(2,j))];
    P(:,j+1) = P(:,j) + V(:,j)*dt;
    j = j+1;
end

% Plot trajectory
PosX = P(1,:);
PosX_sec = PosX(1:1000:end-1000);
PosY = P(2,:);
PosY_sec = PosY(1:1000:end-1000);
VelX = V(1,:);
VelX_sec = VelX(1:1000:end);
VelY = V(2,:);
VelY_sec = VelY(1:1000:end);
figure(1)
plot(PosX,PosY,'color','red')
%comet(PosX,PosY)
hold on
quiver(PosX_sec,PosY_sec,VelX_sec,VelY_sec,'color','blue')
xlabel('$\{x\}$ (m)','interpreter','latex')
ylabel('$\{y\}$ (m)','interpreter','latex')

```

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## Maneuver 2

```
v = 50/2.237; % m/s

% System matrix A
A = [ -((Cf+Cr)/(m*v)) ((Cr*b-Cf*a)/(m*v^2)-1);
      (Cr*b-Cf*a)/Iz    -((Cr*b^2+Cf*a^2)/(Iz*v)) ];

% Control matrix B
B = [ Cf/(m*v); (Cf*a)/Iz ];

% Simulation parameters
dt = 0.001; % s
X(:,1) = [0;0];
Xdot = [];
Xint(:,1) = [0;0];
V = [];
P = [0;0];
j = 1;

% Simulate from t=0 to t=5
U = 0; % Control input (@ 0 deg steering wheel angle)
for i = 0+dt:dt:5
    Xdot(:,j) = A*X(:,j)+B*U;
    X(:,j+1) = X(:,j) + Xdot(:,j)*dt;
```

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    Xint(:,j+1) = Xint(:,j) + X(:,j)*dt;
    V(:,j) = [v*cos(X(1,j)+Xint(2,j)); v*sin(X(1,j)+Xint(2,j))];
    P(:,j+1) = P(:,j) + V(:,j)*dt;
    j = j+1;
end

% Simulate from t=5 to t=23.621
U = 0:((14.5*(pi/180))/G)*dt:(270*(pi/180))/G; % Control input (@ 0-270 deg
steering wheel angle)
for i = 5+dt:dt:23.621
    Xdot(:,j) = A*X(:,j)+B*U(j-5000);
    X(:,j+1) = X(:,j) + Xdot(:,j)*dt;
    Xint(:,j+1) = Xint(:,j) + X(:,j)*dt;
    V(:,j) = [v*cos(X(1,j)+Xint(2,j)); v*sin(X(1,j)+Xint(2,j))];
    P(:,j+1) = P(:,j) + V(:,j)*dt;
    j = j+1;
end

% Simulate from t=23.621 to t=27.621
U = (270*(pi/180))/G; % Control input (@ 270 deg steering wheel angle)
for i = 23.621+dt:dt:27.621
    Xdot(:,j) = A*X(:,j)+B*U;
    X(:,j+1) = X(:,j) + Xdot(:,j)*dt;
    Xint(:,j+1) = Xint(:,j) + X(:,j)*dt;
    V(:,j) = [v*cos(X(1,j)+Xint(2,j)); v*sin(X(1,j)+Xint(2,j))];
    P(:,j+1) = P(:,j) + V(:,j)*dt;
    j = j+1;
end

% Simulate from t=27.621 to t=40
U = 0; % Control input (@ 0 deg steering wheel angle)
for i = 27.621+dt:dt:40
    Xdot(:,j) = A*X(:,j)+B*U;
    X(:,j+1) = X(:,j) + Xdot(:,j)*dt;
    Xint(:,j+1) = Xint(:,j) + X(:,j)*dt;
    V(:,j) = [v*cos(X(1,j)+Xint(2,j)); v*sin(X(1,j)+Xint(2,j))];
    P(:,j+1) = P(:,j) + V(:,j)*dt;
    j = j+1;
end

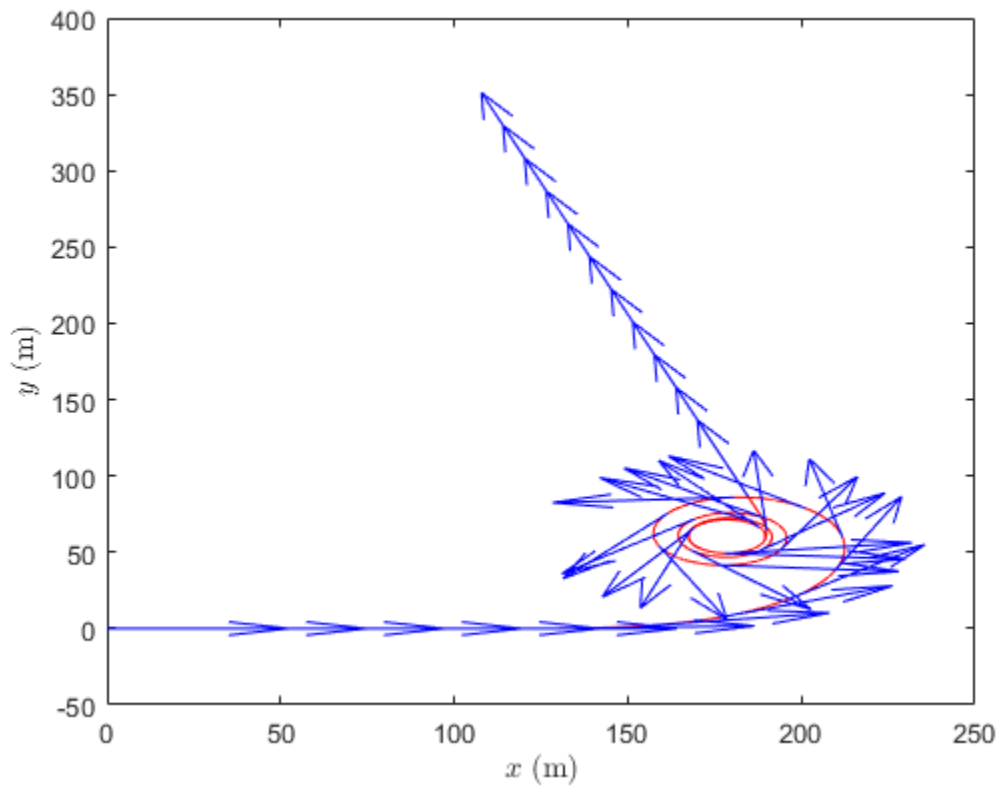
% Plot trajectory
PosX = P(1,:);
PosX_sec = PosX(1:1000:end-1000);
PosY = P(2,:);
PosY_sec = PosY(1:1000:end-1000);
VelX = V(1,:);
VelX_sec = VelX(1:1000:end);
VelY = V(2,:);
VelY_sec = VelY(1:1000:end);
figure(2)
plot(PosX,PosY,'color','red')
%comet(PosX,PosY)
hold on
quiver(PosX_sec,PosY_sec,VelX_sec,VelY_sec,'color','blue')

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```
xlabel('$\{x\}$ (m)','interpreter','latex')  
ylabel('$\{y\}$ (m)','interpreter','latex')
```



*Published with MATLAB® R2022a*