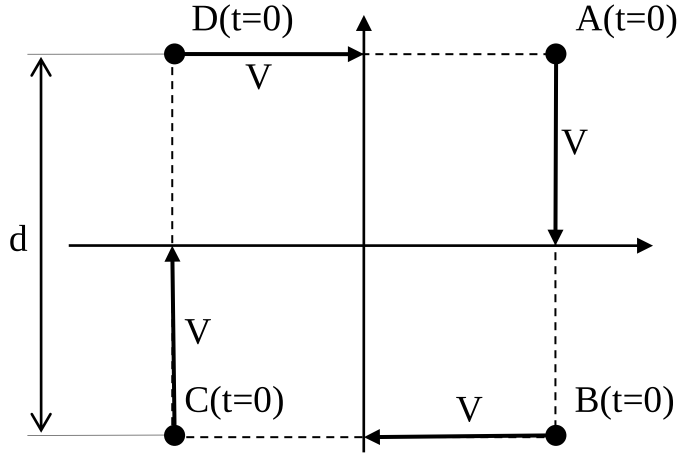
MATLAB, Lab 7 – Group work

Assume that we have four fleas located as presented in figure below



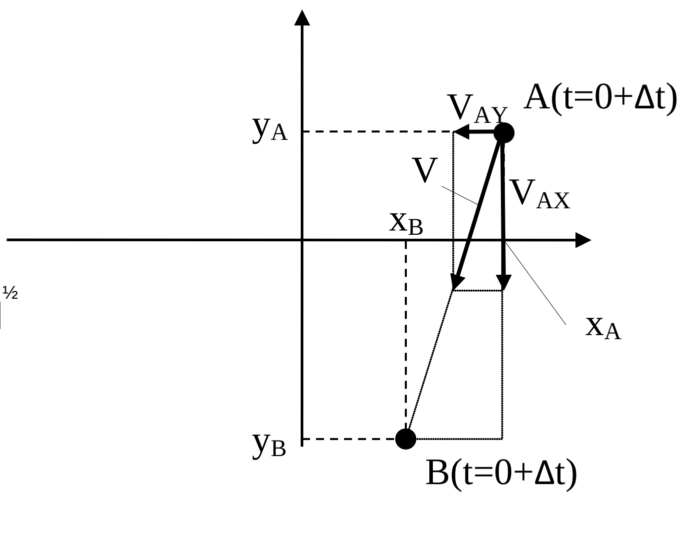
Each of them travels towards its neighbor with velocity V. Flea A always heads towards flea B. Flea B heads towards flea C etc. As the problem is symmetrical, one can analyze only one flea at a time and obtain motion of another fleas by rotating the result by 90, 180 and 270 deg.

Let us consider flea A after certain timestep Δt. It has moved along the segment AB, while flea B moved along the segment BC. This means that the direction of motion of flea A in next timestep will change.

$$x_{A1} = x_{A0}$$
$$y_{A1} = y_{A0} + v \times \Delta t$$

$$Dx_1 = [(x_{A1})-(x_{B1})]$$
$$Dy_1 = [(y_{A1})-(y_{B1})]$$
$$AB_1 = [(Dx_1)^2 + (Dy_1)^2]^{½}$$

$$V_{Ax1} = v \times Dx_1 / AB_1$$
$$V_{Ay1} = v \times Dy_1 / AB_1$$



Note that due to symmetry of the problem, coordinates of flea B are the same as coordinates of flea A rotated by 90 deg clockwise, hence $(x_B,y_B)=(y_A,-x_A)$. Develop the general equations for n-th timestep:

Equations:

xA(ii) = xA(ii-1) + vAx*dt;
yA(ii) = yA(ii-1) + vAy*dt;
xB = yA;
yB = -xA;
xC = -xA;
yC = -yA;
xD = -yA;
yD = xA;
delta_x = xA(ii) - xB(ii);
delta_y = yA(ii) - yB(ii);
d = sqrt(delta_x^2 + delta_y^2);

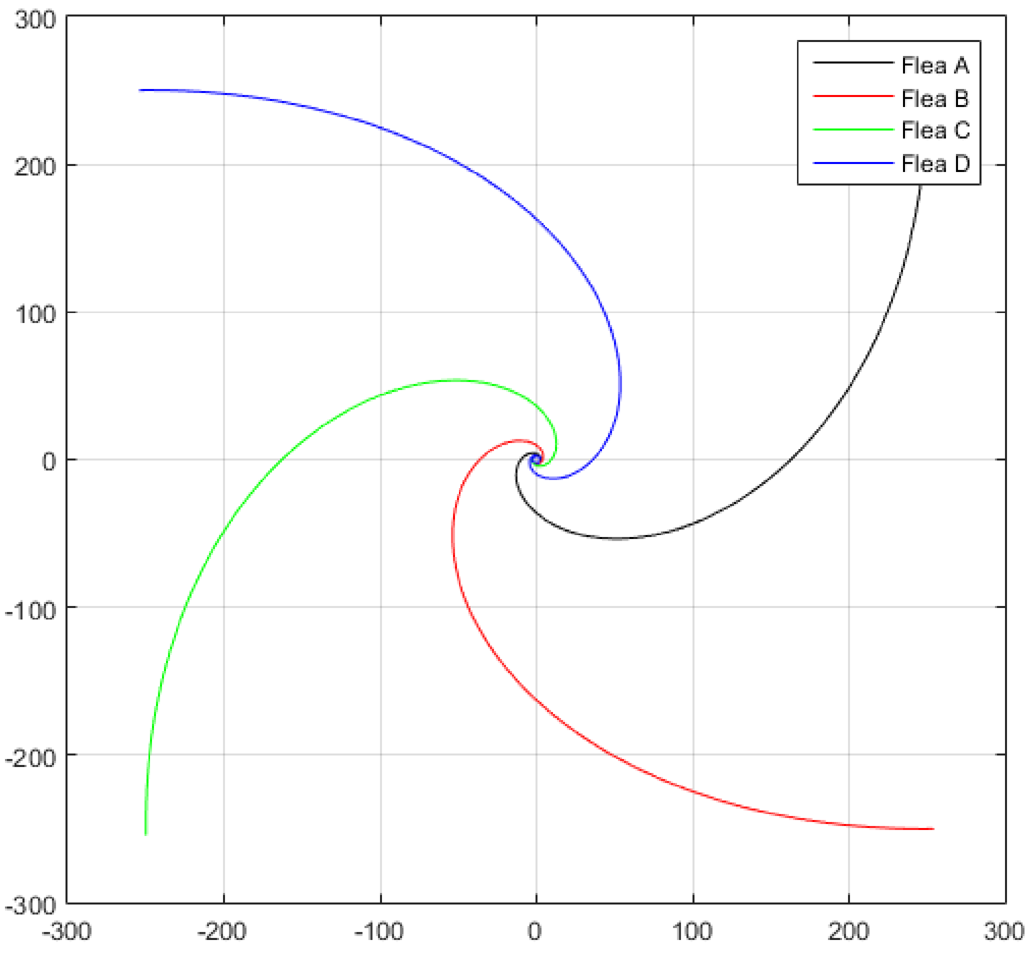
Using equations for n-th timestep and function presented in a lecture develop the program that solves the trajectory of point A in time using Euler method. Assume some values of desired parameters (d, V, Δt). Plot the trajectory of motion of all fleas on one plot. Add a legend. Paste the code performing the algorithm and 3 screenshots obtained with different simulation parameters (d, V, Δt).

Code

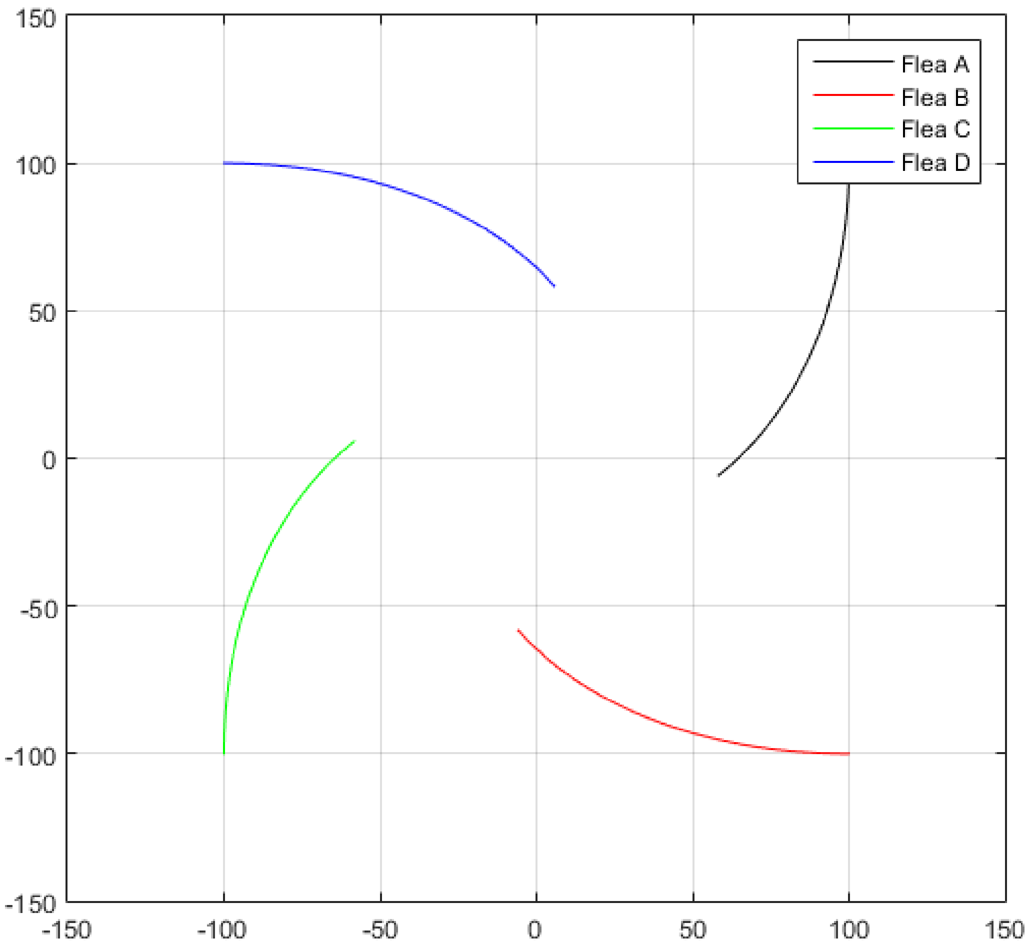
```
function Flea

    v = 3;
    n = 500;
    dt = 0.2;

    xA = zeros (1, n);
    yA = zeros (1, n);
    xB = zeros (1, n);
    yB = zeros (1, n);
    xC = zeros (1, n);
    yC = zeros (1, n);
    xD = zeros (1, n);
    yD = zeros (1, n);

    d(1) = 100
    xA(1) = 0.5*d;
    yA(1) = 0.5*d;
    vAx = 0;
    vAy = v;
    dmin = 0.1;

ii = 2;
while (d > dmin & ii <= n)
    xA(ii) = xA(ii-1) + vAx*dt;
    yA(ii) = yA(ii-1) + vAy*dt;
    xB = yA;
    yB = -xA;
    xC = -xA;
    yC = -yA;
    xD = -yA;
    yD = xA;
    delta_x = xA(ii) - xB(ii);
    delta_y = yA(ii) - yB(ii);
    d = sqrt(delta_x^2 + delta_y^2);
vAx = -v * delta_x/d
vAy = -v * delta_y/d
  ii = ii + 1;
```

```
end;

ii = ii-1;
plot (xA(1:ii), yA(1:ii), 'k', xB(1:ii), yB(1:ii), 'r', xC(1:ii),
yC(1:ii), 'g', xD(1:ii), yD(1:ii), 'b');
legend('Flea A', 'Flea B', 'Flea C', 'Flea D')
grid on;
```

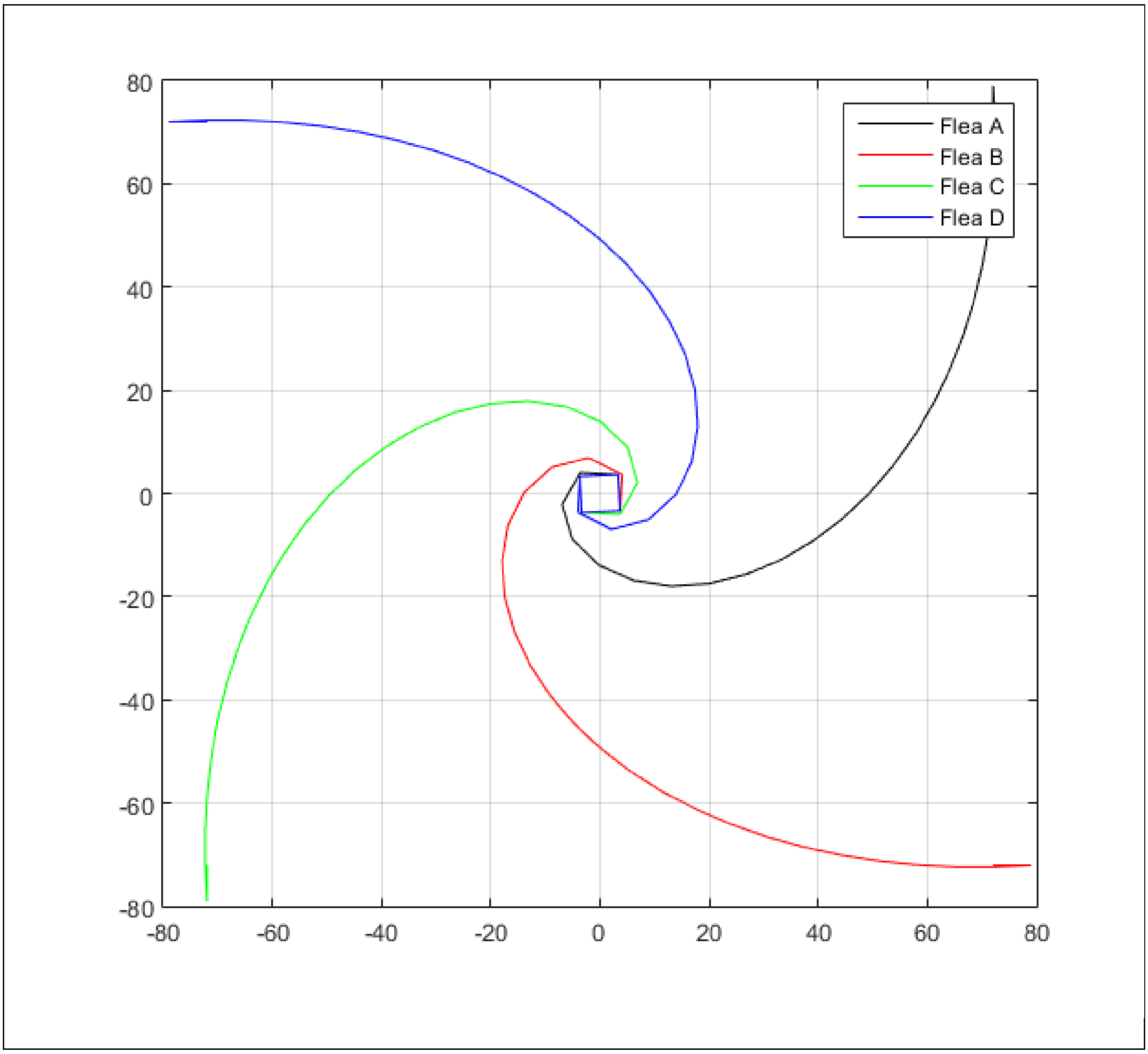
Case 1:
V= 17 d= 500 Δt= 0.25
Screenshot:



Case 2:
V= 3 d= 200 Δt= 0.0789
Screenshot:



Case 3:
V= 10 d= 144 Δt= 0.7
Screenshot:



Flea A
Flea B
Flea C
Flea D
80
60
40
20
0
-20
-40
-60
-80
-80
-60
-40
-20
0
20
40
60
80