% Parameters

Lx = 1; % domain length

Ly = 1; % domain height

nx = 51; % number of grid points in x-direction

ny = 51; % number of grid points in y-direction

dx = Lx/(nx-1); % grid spacing in x-direction

dy = Ly/(ny-1); % grid spacing in y-direction

x = linspace(0,Lx,nx); % x-coordinate vector

y = linspace(0,Ly,ny); % y-coordinate vector

u = 1; % velocity

D = 0.1; % diffusivity

P = 1; % porosity

C0 = 1; % inlet concentration

Cout = 0; % outlet concentration

% Define the coefficient matrices

Ax = (D/u)\*sparse(2:nx,1:nx-1,1,nx,nx)+...

(-2\*D/u)\*speye(nx)+...

(D/u)\*sparse(1:nx-1,2:nx,1,nx,nx);

Ay = (D/u)\*sparse(2:ny,1:ny-1,1,ny,ny)+...

(-2\*D/u)\*speye(ny)+...

(D/u)\*sparse(1:ny-1,2:ny,1,ny,ny);

B = speye(nx\*ny);

for i = 1:ny-1

B((i-1)\*nx+1:i\*nx,(i-1)\*nx+1:i\*nx) = Ax;

end

for i = 1:nx

B((ny-1)\*nx+i,(ny-2)\*nx+i) = (D/u)\*1;

end

for i = 2:nx-1

B(i,i+nx) = (D/u)\*1;

end

for i = 2:ny-1

B((i-1)\*nx+1,i\*nx+1) = (D/u)\*1;

end

for i = 1:ny

B(i\*nx,i\*nx) = (D/u)\*1;

end

% Inlet and outlet boundary conditions

bc = zeros(nx\*ny,1);

bc(1:nx) = C0;

bc((ny-1)\*nx+1:ny\*nx) = Cout;

% Solve the system of linear equations

C = P\*(B\bc);

% Reshape the concentration vector into a 2D array

C = reshape(C,nx,ny)';

% Plot the concentration field

[X,Y] = meshgrid(x,y);

surf(X,Y,C)

xlabel('x')

ylabel('y')

zlabel('C')