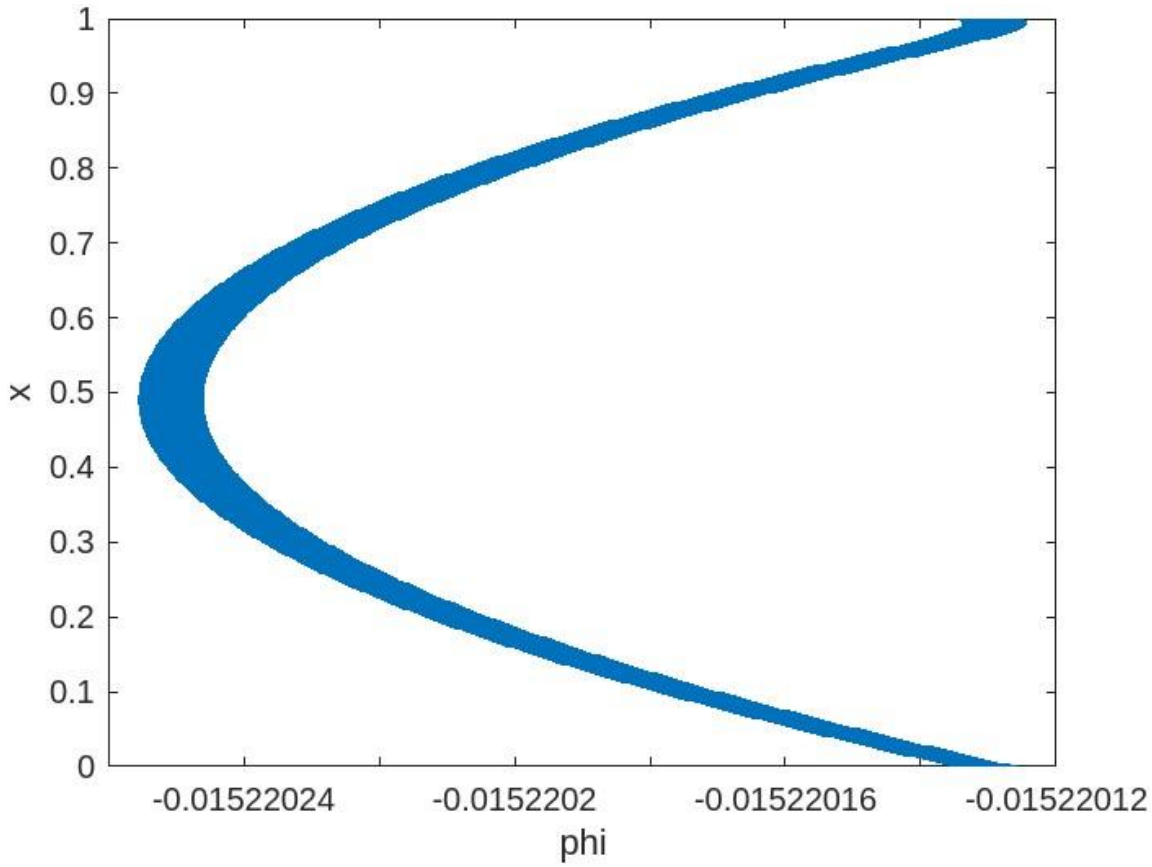
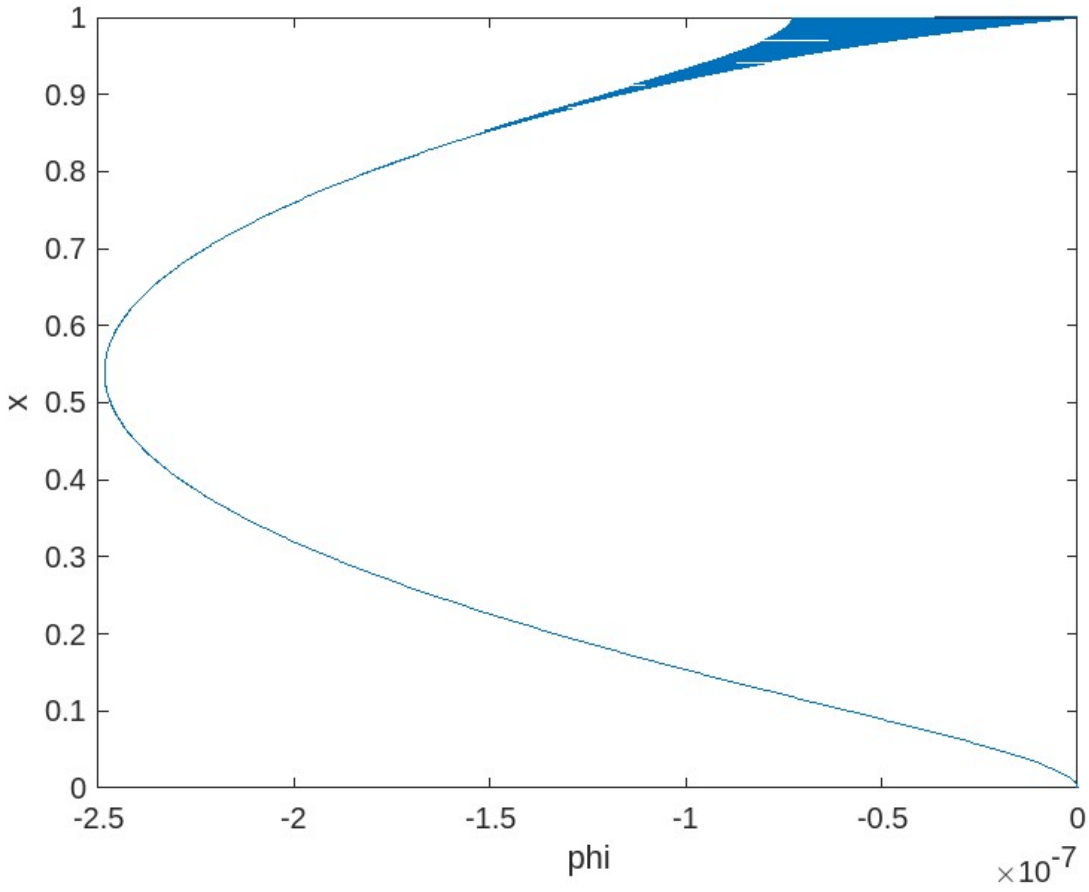
1-D Steady State Convection Diffusion with Porous Medium MATLAB Code:

```
% define variables
L=1; % length of rod
n=101; % number of grid points
dx=L/(n-1); % Grid spacing
x=linspace(0,L,n); % Grid points
density=19300; % Density of material
u=1; % Velocity of particle
gamma=0.5; % coefficient
mu=4.84
k=318

S=x.*(x-1);  % define the source term

% define the initial condition
phi=zeros(1,n);
phi=x.^2;

% define the matrix for the finite difference method
A=zeros(n,n);
A(1,1) = 1;
for i = 2:n-1
    A(i,i-1) = +density*u/(2*dx) + gamma/dx^2;
    A(i,i) = 2*gamma/dx^2;
    A(i,i+1) = -density*u/(2*dx) + gamma/dx^2;
end
A(n,n)=1;

% solve for the steady state solution
phi=A\S'-mu*u/k;

% plot the graph
plot(phi,x);
xlabel('phi');
ylabel('x');
```


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
x
-0.01522024
-0.0152202
-0.01522016
-0.01522012
phi

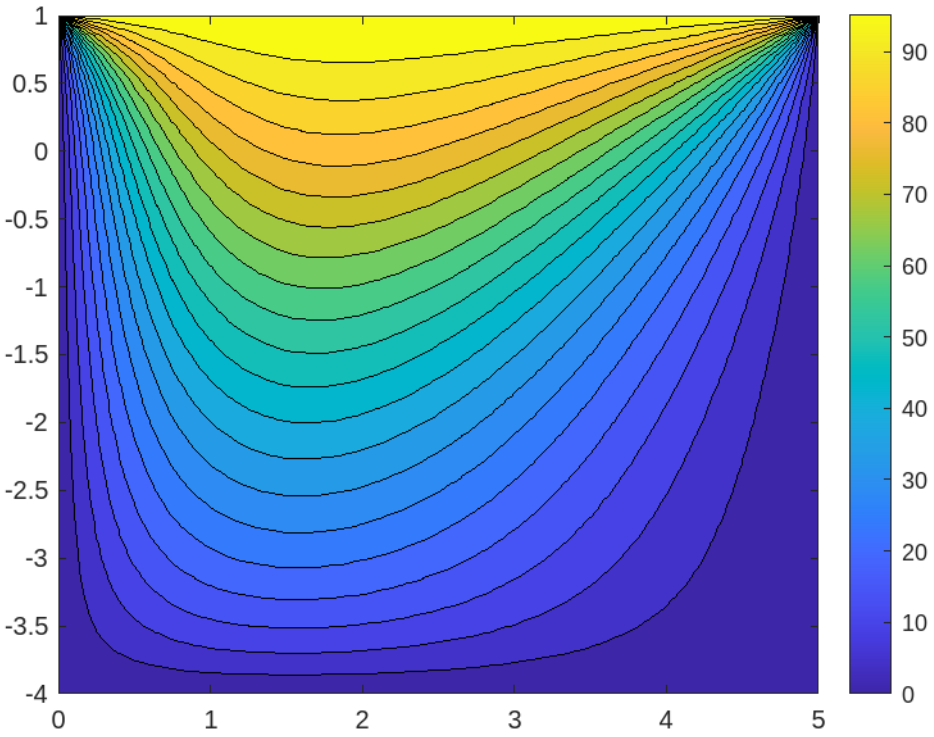
1-D Steady State Convection Diffusion without Porous Medium MATLAB Code:

```
% define variables
L=1; % length of rod
n=1001; % number of grid points
dx=L/(n-1); % Grid spacing
x=linspace(0,L,n); % Grid points
density=19300; % Density of material
u=1; % Velocity of particle
gamma=0.5; % coefficient
S=x.*(x-1); % define the source term

% define the initial condition
phi=zeros(1,n);
phi=x.^2;

% define the matrix for the finite difference method
A=zeros(n,n);
A(1,1) = 1;
for i = 2:n-1
    A(i,i-1) = -density*u/dx - gamma/dx^2;
    A(i,i) = 2*gamma/dx^2;
    A(i,i+1) = density*u/dx + gamma/dx^2;
end
A(n,n)=1;

% solve for the steady state solution
phi=A\S';

% plot the graph
plot(phi,x);
xlabel('phi');
ylabel('x');
```


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
x
-2.5
-2
-1.5
-1
-0.5
0
phi
×10-7

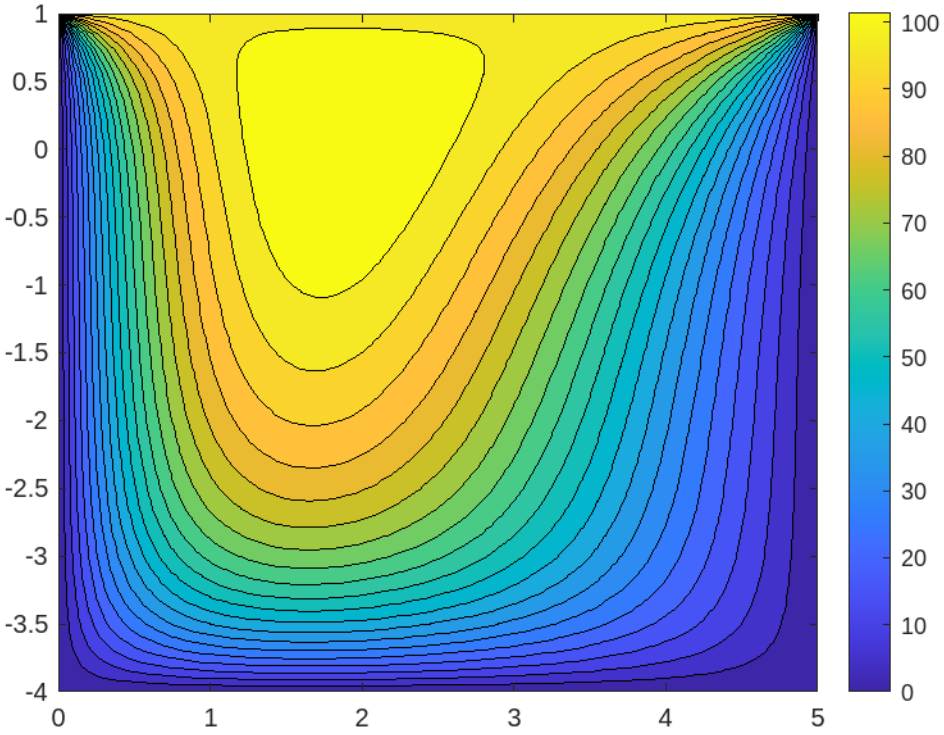
MATLAB CODE FOR 2D CONVECTION-DIFFUSION

```
L = 5; % length of rod
n_points = 101; % n_points = nx = ny
h = L/(n_points-1); % h = dx = dy = L/(n_points-1)
x = 0:h:L;
y = 0:h:L;

T(1, 1:n_points) = 0;
T(1:n_points, 1) = 25;
T_new(1, 1:n_points) = 100;
T_new(1:n_points, 1) = 0;

rho = 1; %density of material
u = 1; %velocity in x direction
v = 1; %velocity in y direction
gamma = 0.05;

error = 1;
itr = 0;
while error > 1e-7
    for i = 2:n_points-1
          for j = 2:n_points-1
                aE = gamma/h - rho*u*h/2;
                aW = gamma/h + rho*u*h/2;
                aN = gamma/h - rho*v*h/2;
                aS = gamma/h + rho*v*h/2;
                aP = aE + aW + aS + aN + 0;
                T_new(i,j) = (aE*T(i+1,j) + aW*T(i-1,j) + aN*T(i, j-1) + aS*T(i,
j+1))/aP;
          end
    end
    itr = itr + 1;
    error = 0;
    for i = 2:n_points-1
        for j = 2:n_points-1
            error = error + abs(T(i,j)-T_new(i,j));
        end
    end
    T = T_new;
end


x_L = ((1:n_points)-1).*h;
y_L = 1-((1:n_points)-1).*h;
[X,Y] = meshgrid(x_L, y_L);
contourf(X,Y,T,20);
colorbar;

figure;
plot(1-y,T(:, (n_points+1)/2),'--o');
```


1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
0
1
2
3
4
5
90
80
70
60
50
40
30
20
10
0

MATLAB CODE FOR 2D CONVECTION-DIFFUSION WITH POROUS MEDIA

```
L = 5; % length of rod
n_points = 101; % n_points = nx = ny
h = L/(n_points-1); % h = dx = dy = L/(n_points-1)
x = 0:h:L;
y = 0:h:L;

T(1, 1:n_points) = 0;
T(1:n_points, 1) = 25;
T_new(1, 1:n_points) = 100;
T_new(1:n_points, 1) = 0;

rho = 1; %density of material
u = 1; %velocity in x direction
v = 1; %velocity in y direction
mu=1e-2; %dynamic viscosity
k=1; %permiability of porous media
gamma = 0.05;

error = 1;
itr = 0;
while error > 1e-7
    for i = 2:n_points-1
           for j = 2:n_points-1
                  aE = gamma/h - rho*u*h/2;
                  aW = gamma/h + rho*u*h/2;
                  aN = gamma/h - rho*v*h/2;
                  aS = gamma/h + rho*v*h/2;
                  aP = aE + aW + aS + aN + 0;
                  T_new(i,j) = (aE*T(i+1,j) + aW*T(i-1,j) + aN*T(i, j-1) + aS*T(i,
j+1))/aP+(mu*u)*h*h/k+(mu*v)*h*h/k;
           end
    end
    itr = itr + 1;
    error = 0;
    for i = 2:n_points-1
        for j = 2:n_points-1
            error = error + abs(T(i,j)-T_new(i,j));
        end
    end
    T = T_new;
end


x_L = ((1:n_points)-1).*h;
y_L = 1-((1:n_points)-1).*h;
[X,Y] = meshgrid(x_L, y_L);
contourf(X,Y,T,20);
colorbar;

figure;
plot(1-y,T(:, (n_points+1)/2),'--o');
```


1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
0
1
2
3
4
5
100
90
80
70
60
50
40
30
20
10
0