Finite Elements In Fluid

Steady convection-diffusion

Numerical examples

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Include the GLS method

The code have to work for linear and quadratic element,Modify the code to solve a steady convection-diffusion reaction problem with zero Dirichlet boundary conditions on the outlet boundary. Compare the methods' behavior to the one observed when Neumann boundary conditions were imposed.

Solve the problem for

• A convection-reaction dominated case with

$||a||=1/2$, $\nu=10^{-4}$, $\sigma=1$

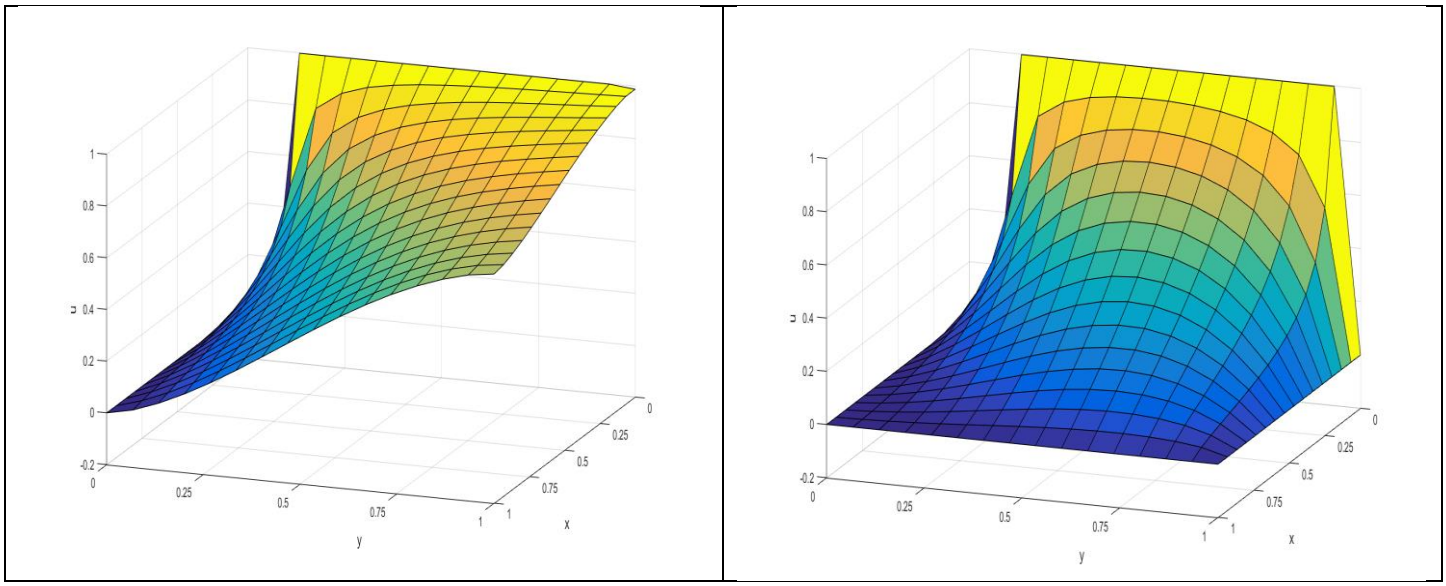


Figure 1 Neumann And Dirichlet condition

• A reaction dominated case with

$||a||=10^{-3}$, $\nu=10^{-4}$, $\sigma=1$

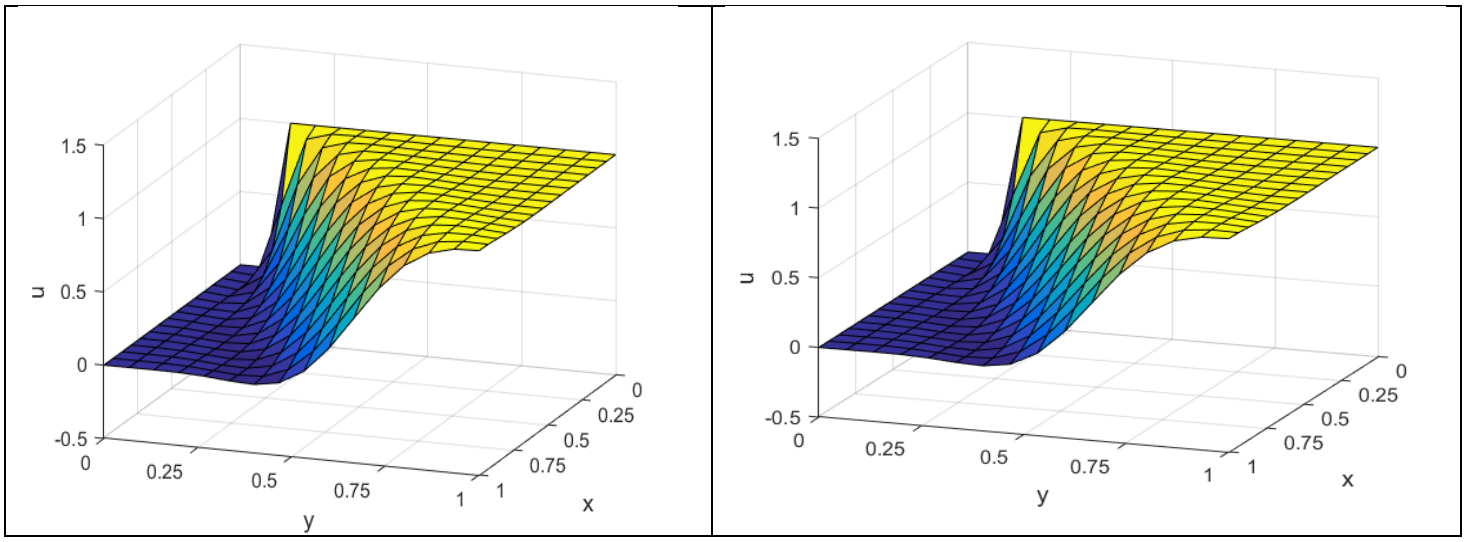


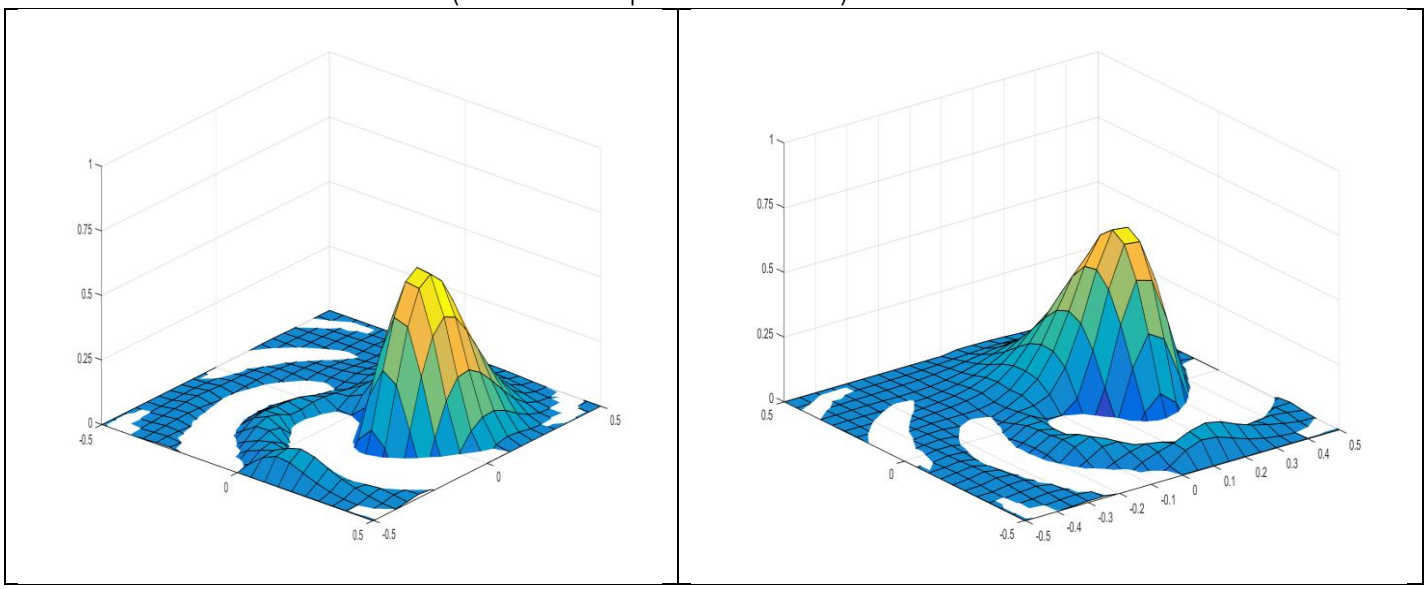
Figure 2 Neumann And Dirichlet

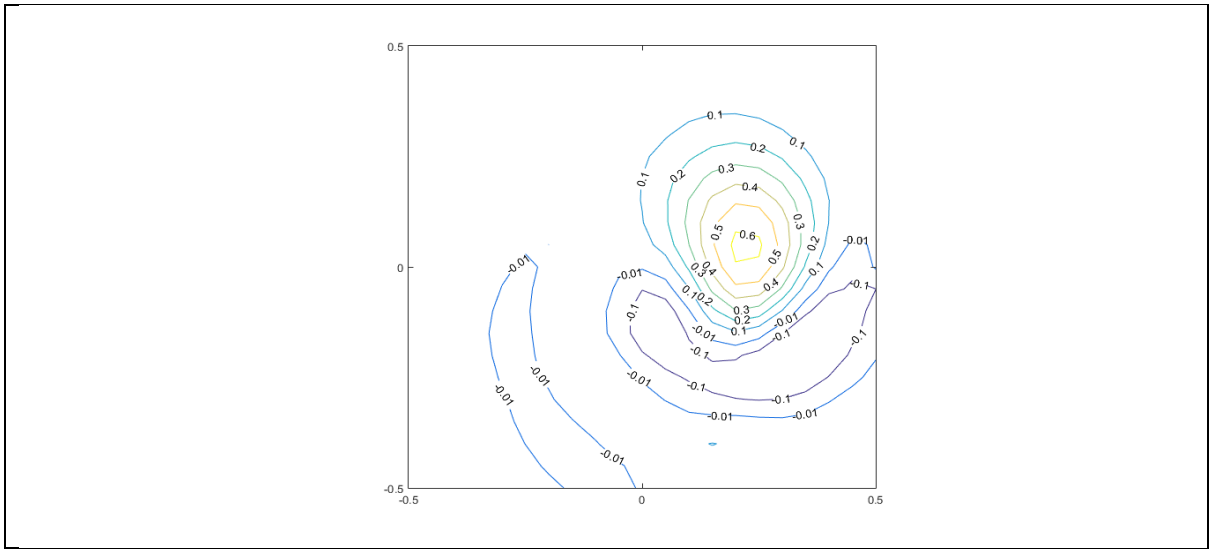
The results show the plot of both the casesplot shows the transport of the flow until reach the boundry layer and the value of the velocity become zero.

You need to finish the code to be able to solve the problem
using
1. Lax-Wendroff + Galerkin (and with lumped mass matrix)
2. Crank-Nicolson + Galerkin (and lumped mass matrix)
3. TG3
4. A two-step high order method
5. Other high order method.
Write down the time and spatial discretization and identify each term of the code. Comment them accordingly
Discuss the behavior of the methods.

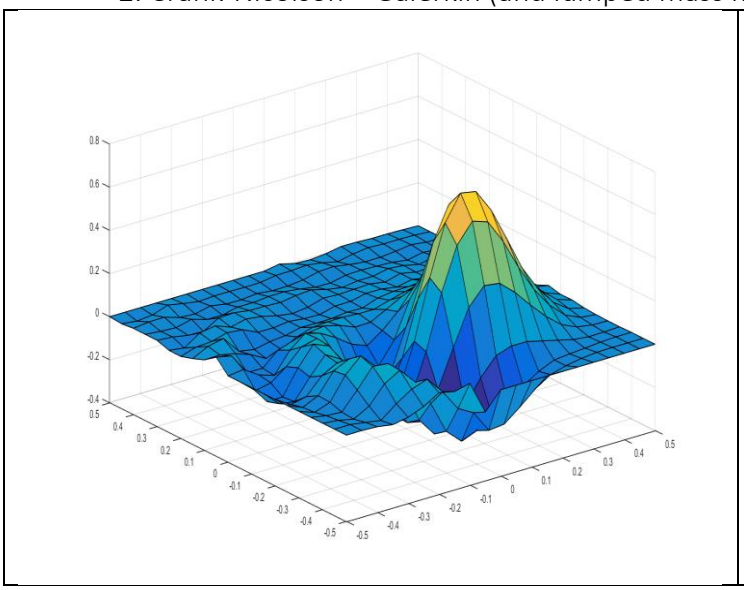
Ans.

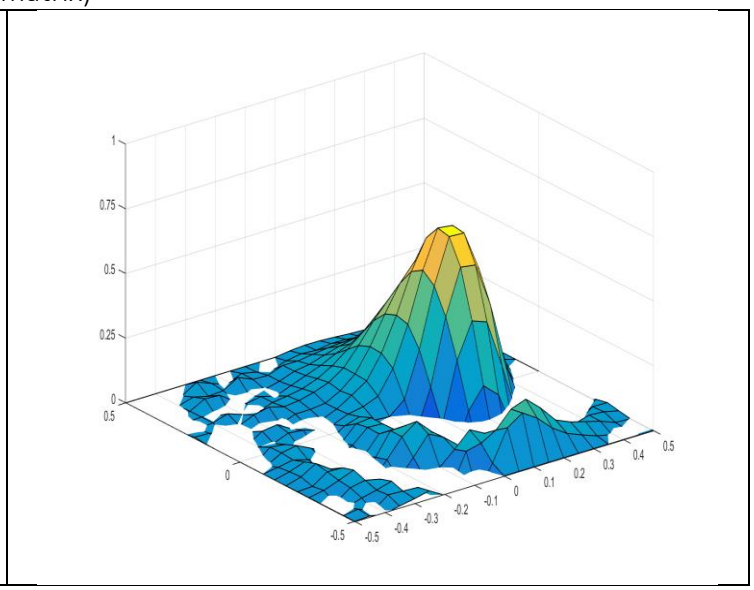
1. Lax-Wendroff + Galerkin (and with lumped mass matrix)

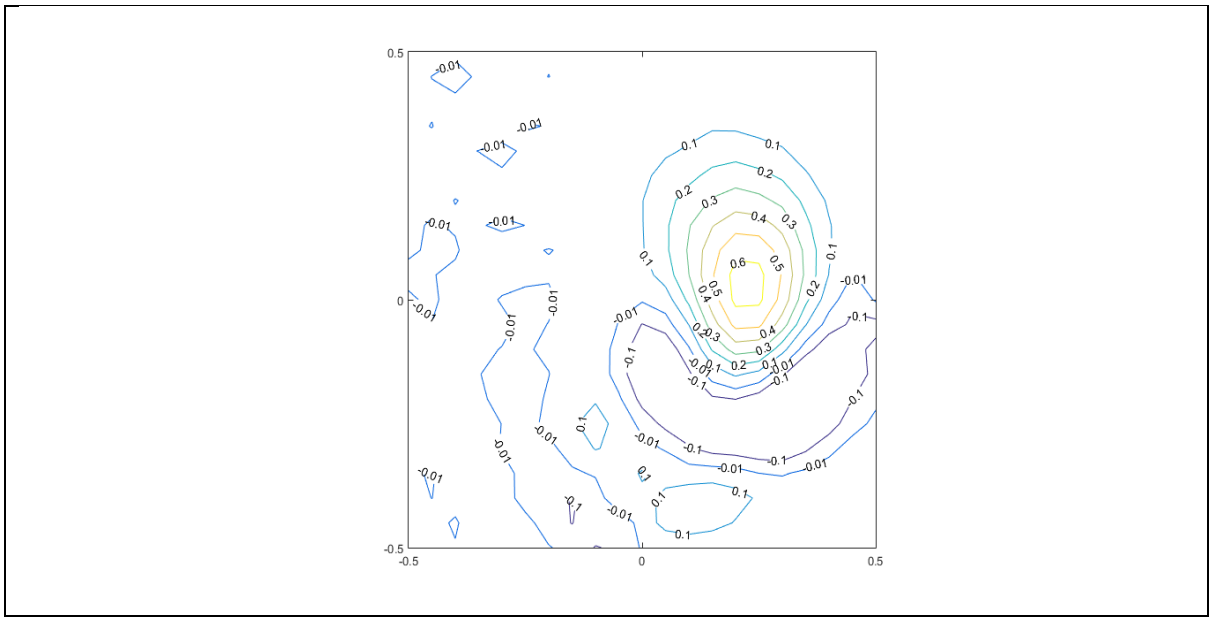




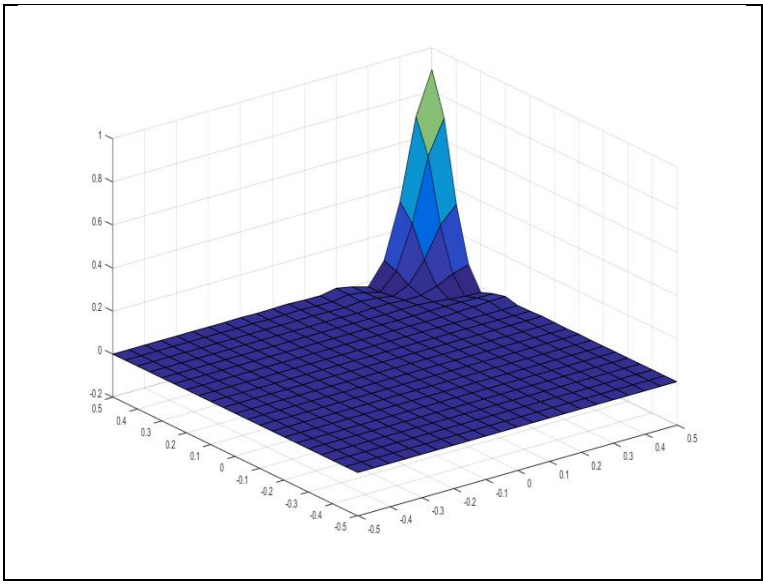
2. Crank-Nicolson + Galerkin (and lumped mass matrix)







3. TG3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0.4
0.2
0
-0.2
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.5
-0.4
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0
0.1
0.2
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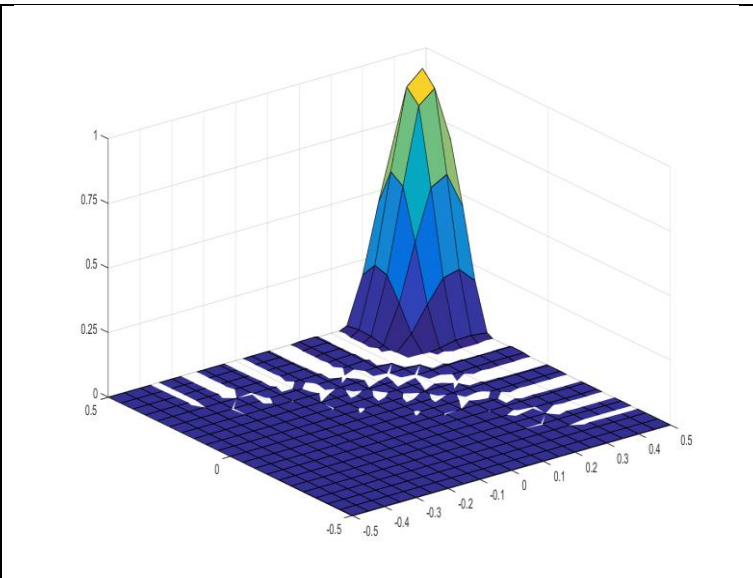
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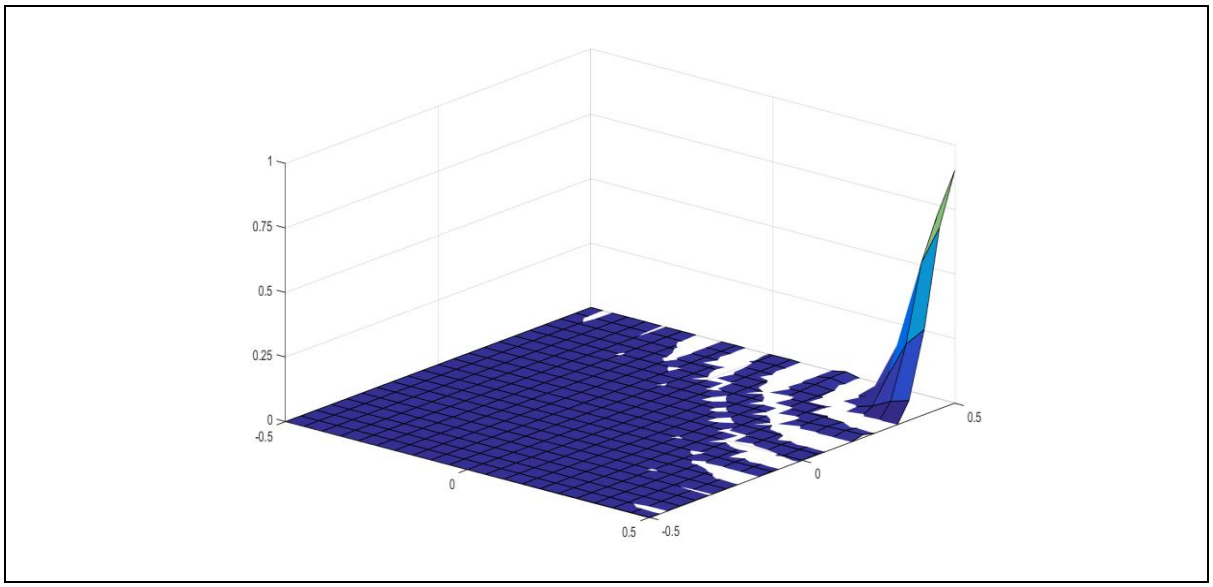
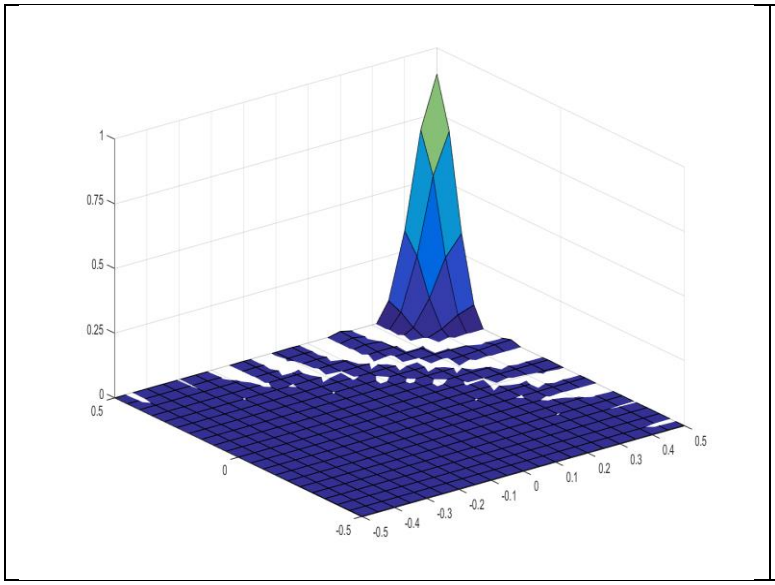
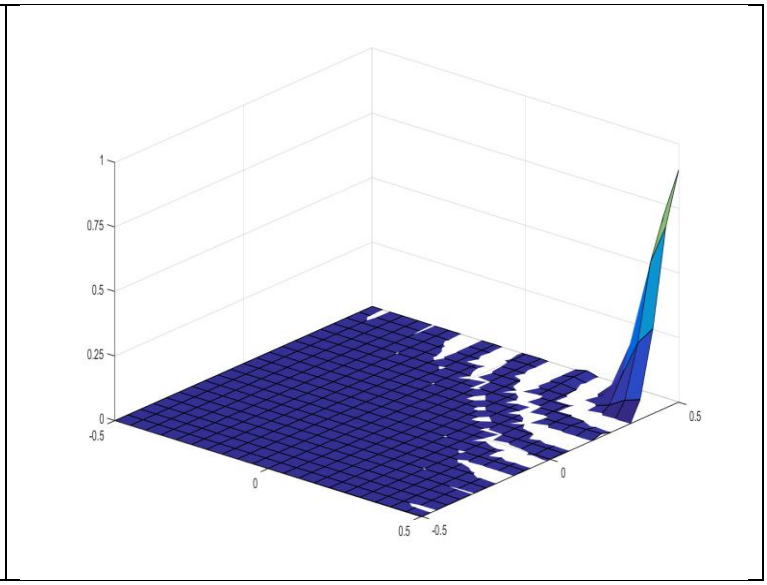
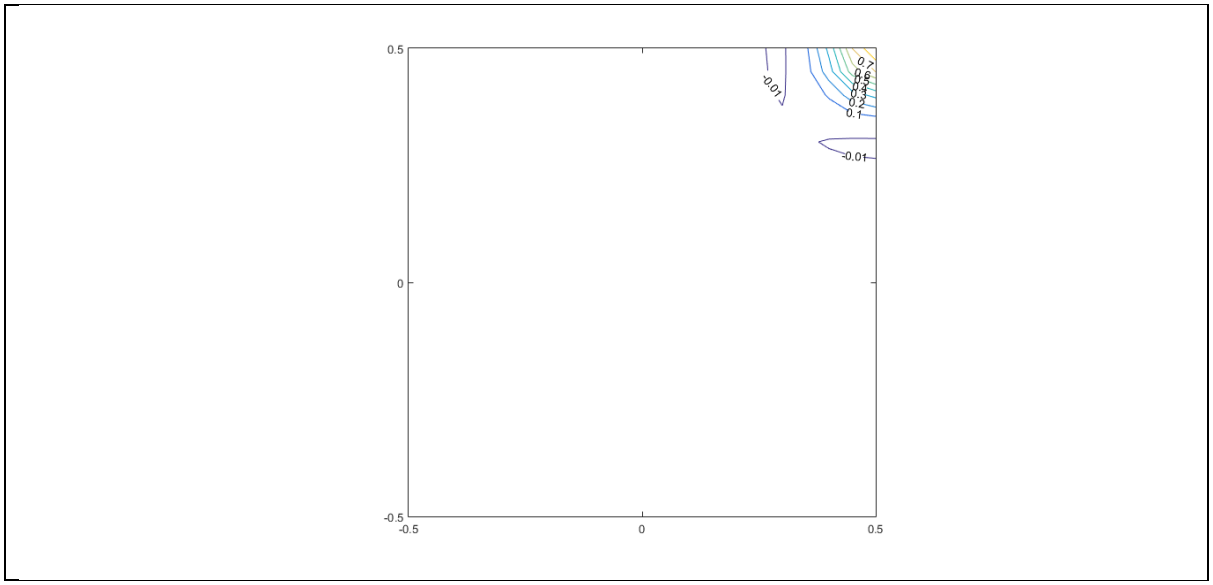
0.25
0
0.5
0
-0.5
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5


1
0.75
0.5
0.25
0
-0.5
0
0.5
0.5
0
-0.5

4. A two-step high order method







This test considers convection of a product cosine hill in pure rotation velocity field.The accuracy of TG3 clearly appearing in the graphs as it is higher order method. For all the methods numerical cone rotating obtained. The time step of all the method is kept same and so that we can see the difference in the results. When I change the time step in crank Nicolson method, the phase accuracy decreased.