Mandatory assignment 1, MEK4300

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I have added all the python code with the email as .py files.

i)

In the first exercise we verified the analytical solutions of Poiseuille flow on three different geometries. Ellipse, eccentric annulus and equilateral triangle
First we look at Ellipse:

Mesh size	CG	u-error	Q-error
0.349693241221	1	0.0175131635342	0.201811218507
0.180720615753	1	0.033365539562	0.283682791213
0.119623532036	1	0.0369504946463	0.298759959614
0.349693241221	2	0.0404398006589	0.309109678417
0.180720615753	2	0.0395051126483	0.312338039779
0.119623532036	2	0.0393769579412	0.312804233035

Triangle:

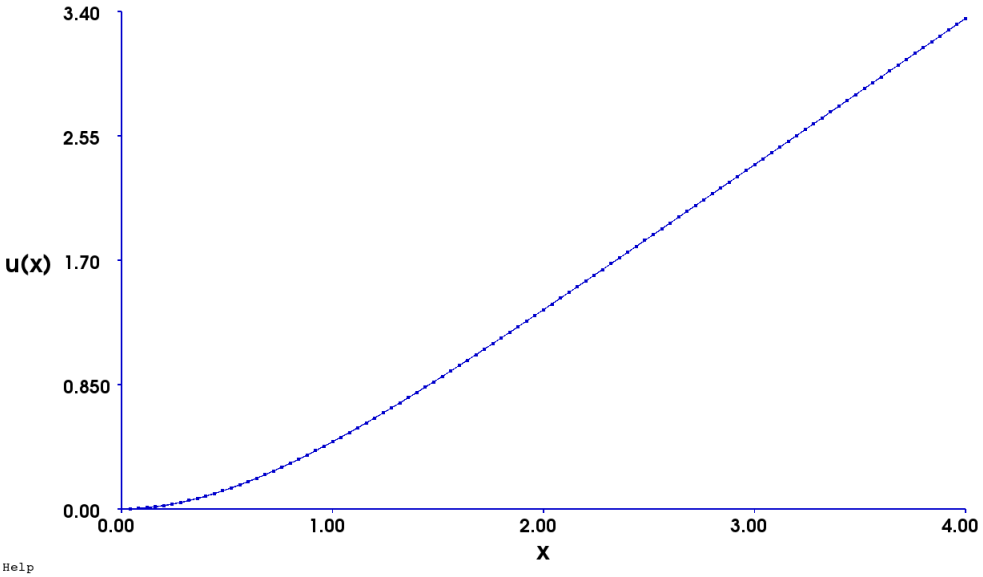
Mesh size	CG	u-error	Q-error
0.241111111111	1	1.20998709897	0.0250047363901
0.119935369941	1	1.20863104525	0.00748744892452
0.0744466995367	1	1.20886207311	0.00314150422326
0.241111111111	2	1.20888275059	3.08070312616e-05
0.119935369941	2	1.20889036886	2.16354879279e-06
0.0744466995367	2	1.20889077371	4.33605035322e-07

Eccentric annulus:

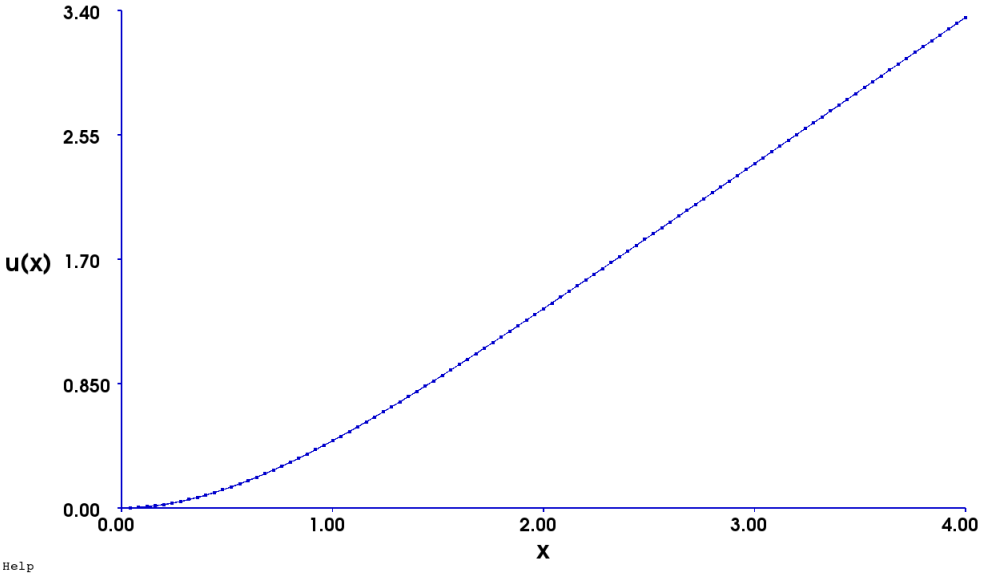
Mesh size	CG	Q-error
0.281069159834	1	4.52547426458
0.199165514514	1	1.8915523401
0.136943057055	1	0.957647075101
0.281069159834	2	3.38015721345
0.199165514514	2	1.36516979556
0.136943057055	2	0.664770215439

ii)

In part 2 we do not have an analytical solution, so i added a picture of the plot of F vs x. Where I have used CG 2 elements. The first picture is for Newton:



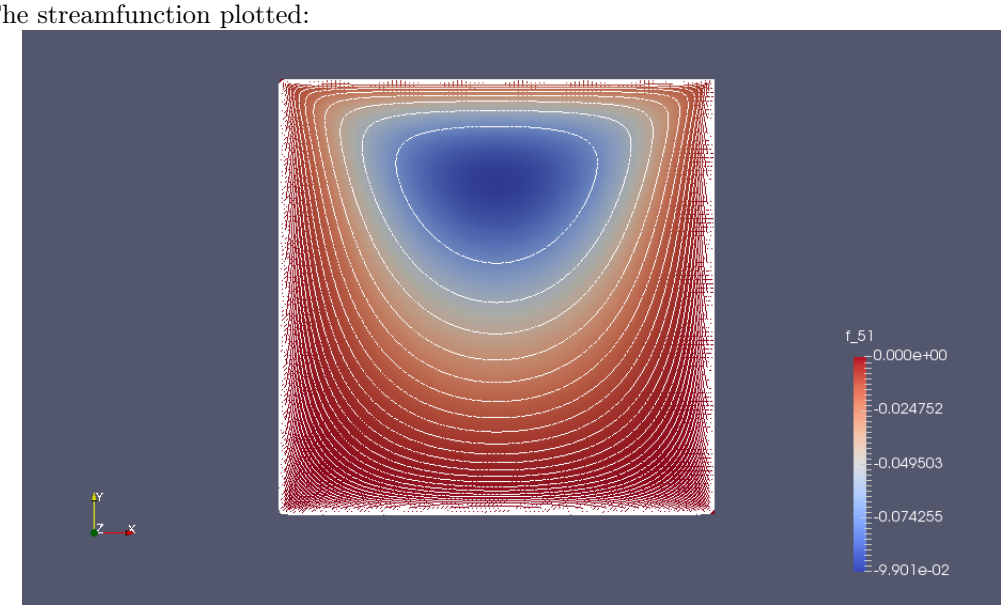
Next is Picard:



Since the two solutions look similar they seem to be correct.

iii)

In this exercise we were asked to compute the position of the central eddy, which is formed from stokes flow in a cavity driven square. I computed the streamfunction, and used its lowest value since the cavity had a positive(right) direction, to find the where the eddy had a center.
The streamfunction plotted:

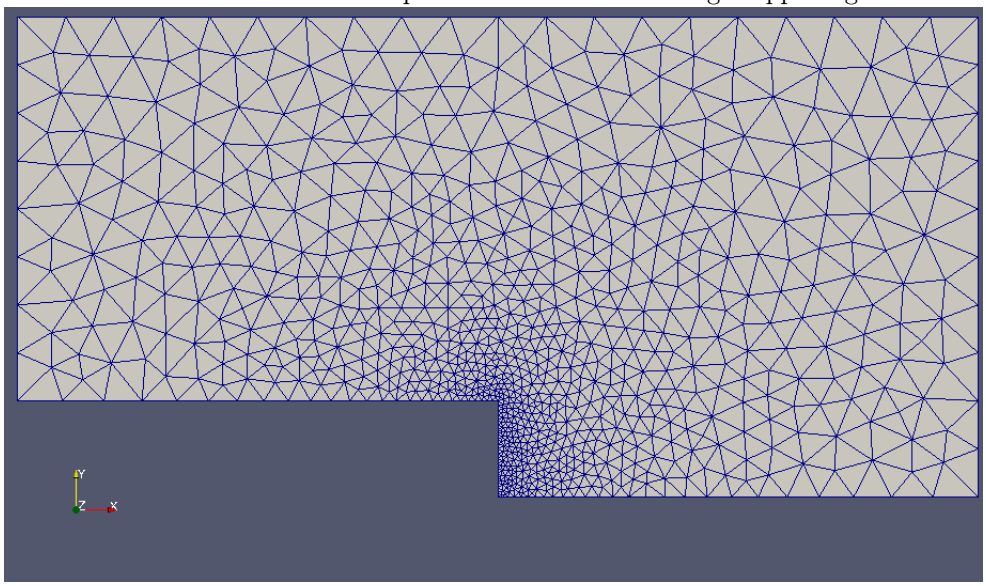


I found the center eddys location to be (0.50, 0.76)

iv)

a)

We were asked to make a rectangular mesh with a step. The length of the mesh was L and sides where 0.5L and the step was 0.1 L. I made the mesh so that origo was at the bottom of the mesh, in the middle, directly beneath the edge. I also made the mesh more fine at the step since there are more things happening here.



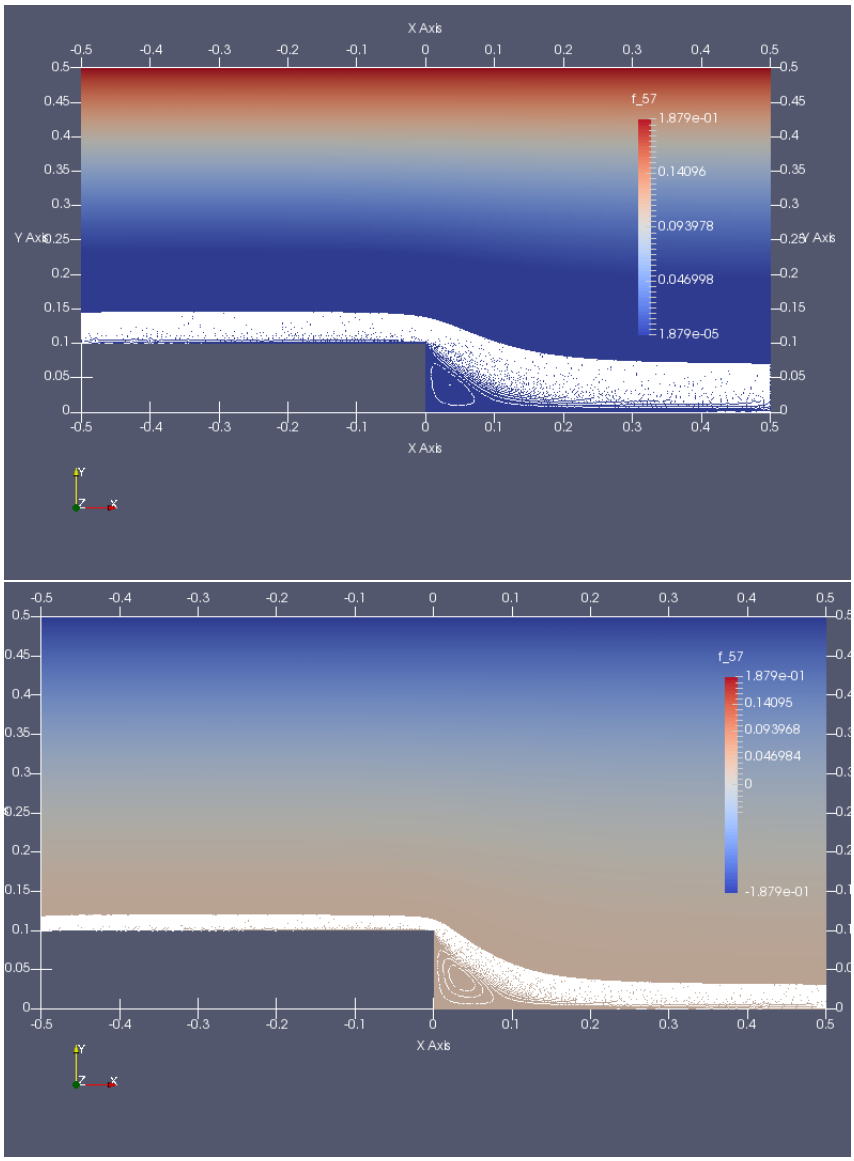
In this exercise i did the same procedure as the iii), only now computing the streamfunction with weak boundary condtions instead of Dirichlet. I found the position of the main eddy with three different meshes:

Vertices	Cells	Center eddy
79	127	(-0.5000, 0.1000)
4790	9305	(-0.4614, 0.1000)
18731	36914	(0.0353, 0.0392)
74127	147160	(0.0351, 0.0392)

Where the two last seem most logical taken the mesh in consideration.

b)

Here are two picture of the streamfunction over the step in both positive and negative direction:



c)

In this section I calculated the flux going in and out of the left and right side of the boundary. And got:
Flux left: -0.212606783972
Flux right: 0.212605013813

Since these numbers are almost identical and with opposite signs, we can say mass is being conserved.

d)

If we reverse the direction we can see from the pictures that the vortex stays in the same spot. This is because the step is geometrically the only thing causing a vortex regardless of direction. The step is causing a change in velocity and pressure, giving the fluid rotation.

e)

In this section we calculated the normal stress on the floor". And could see when we sent the flow down the step that we have a stress going down in the floor"and the opposite happening when we sent the flow up the stairs. This coincides with what we observe with airplanes getting positive force to fly.
In positive direction:
Normal stress: 121.504028211
In negative direction :
Normal stress: -121.504028211