Lab 1

Engineering 1282.02H

Spring 2020

Jess Timog

C. Wallwey GTA MWF 12:40PM

Date of Submission: 2/24/2020

INSTRUCTIONS:

- Complete this worksheet as you follow APP N06-1.1 TUTORIAL.
- Type all written responses/calculations as necessary.
- Properly format any figures or tables with appropriate captions, units, etc.
- Check formatting of this document after completion, as page breaks will move as you fill out the worksheet
- Save this document so that you can combine it with APP N06-1.2. You will submit the combined APP N06-1.1 and APP N06-1.2 as APP N06-1.

Coarse Mesh:

1. Insert screenshot of your goals plot from step 31 below:

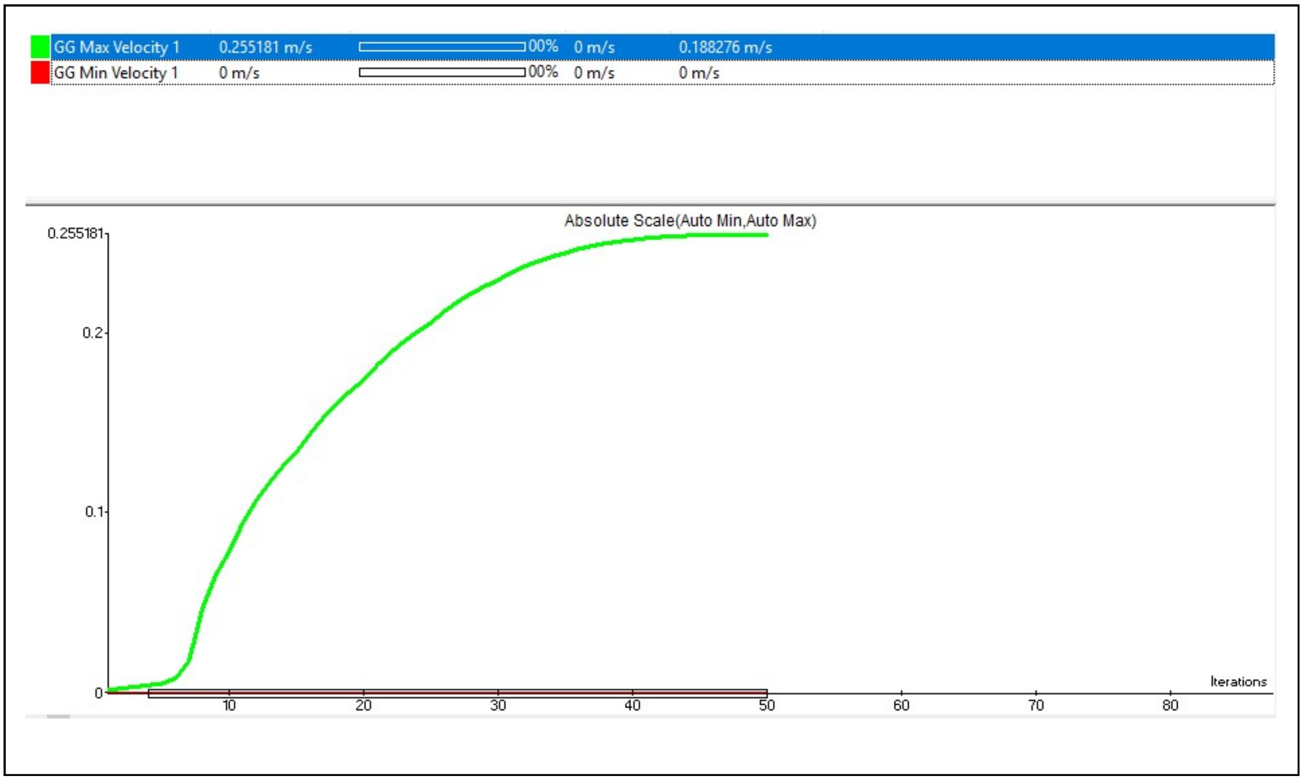


Figure 1: Graph of Step 31 of Goals Plot.

2. Insert screenshot of your pressure contour surface plot from step 41 below:

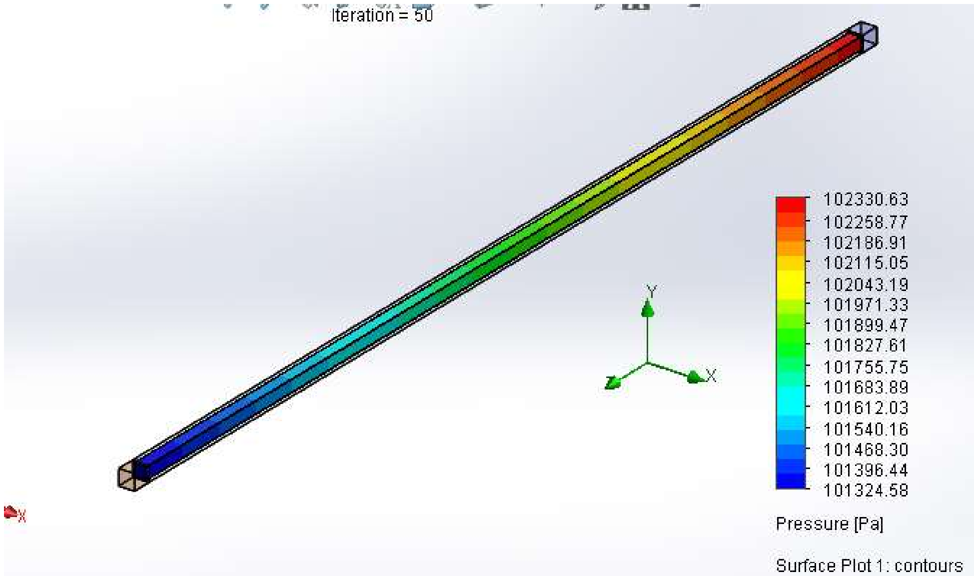
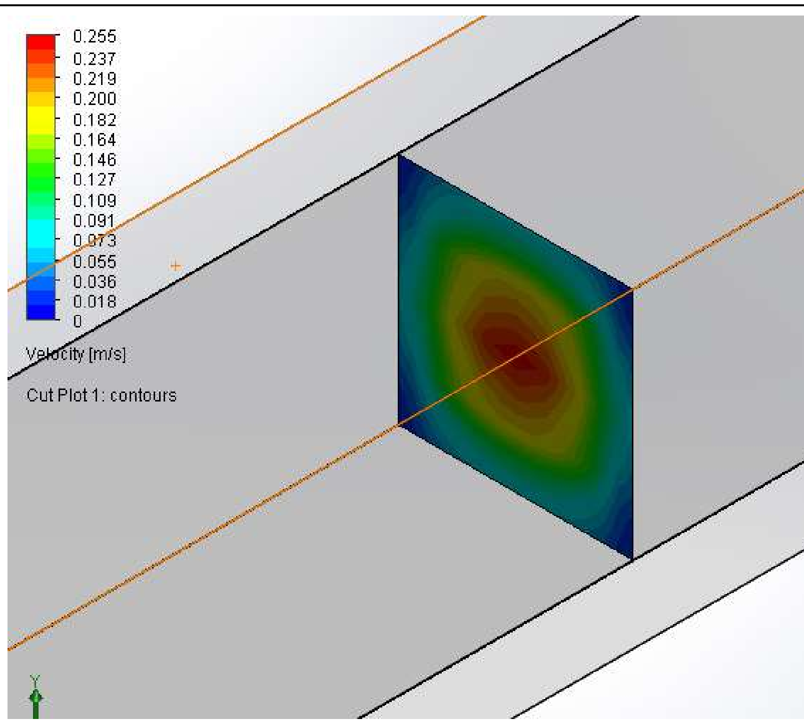


Figure 2: Pressure Contour Surface Plot of Step 41

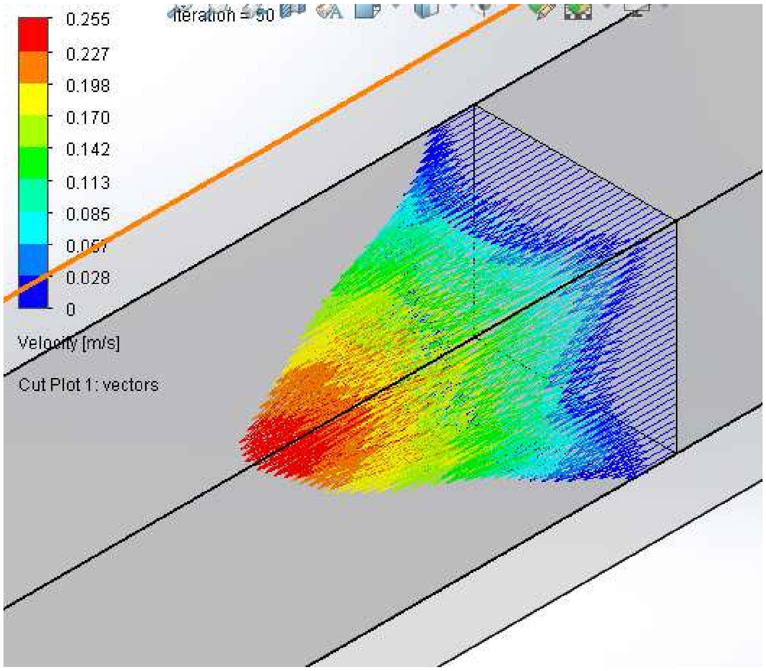
3. Insert screenshot of your Velocity Contours (z = 0.010 m) from step 44 below:



Lightbulb did not show up and geometry was off

Figure 3: Velocity Contours from Step 44.

4. Insert a screenshot of your Velocity Vectors (z = 0.010 m) from step 46 below:



Geometry was off

Figure 4: Velocity Vectors from Step 46.

5. Insert a screenshot of your Flow Trajectories from step 48 below:

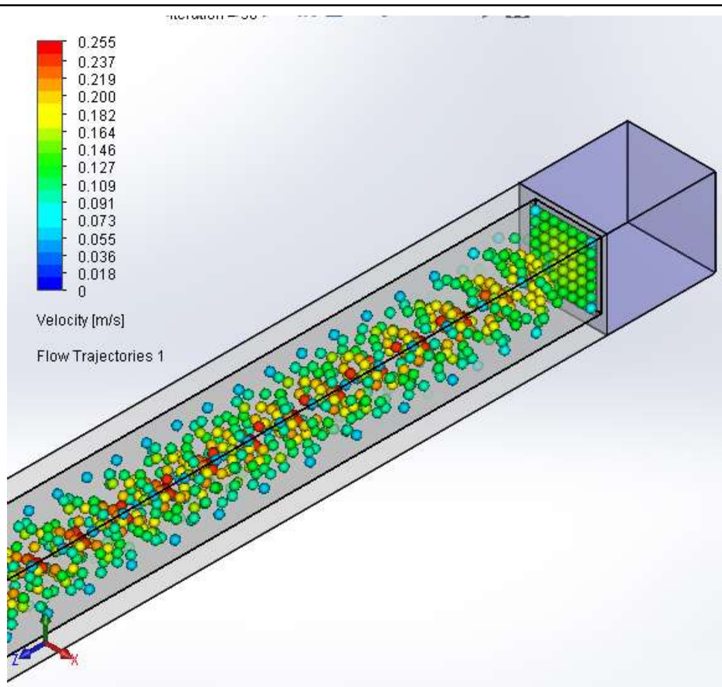


Figure 5: Flow Trajectories as Spheres from Step 48.

Fine Mesh:

6. Insert a screenshot of your Goals Plot from step 56 below:

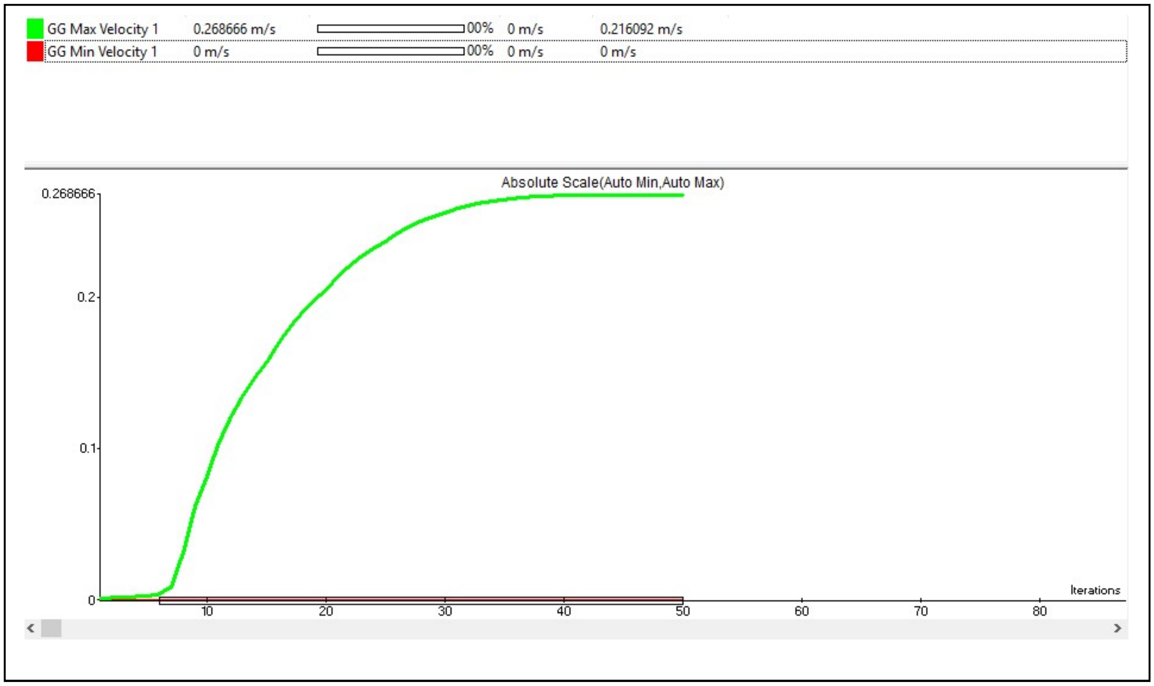
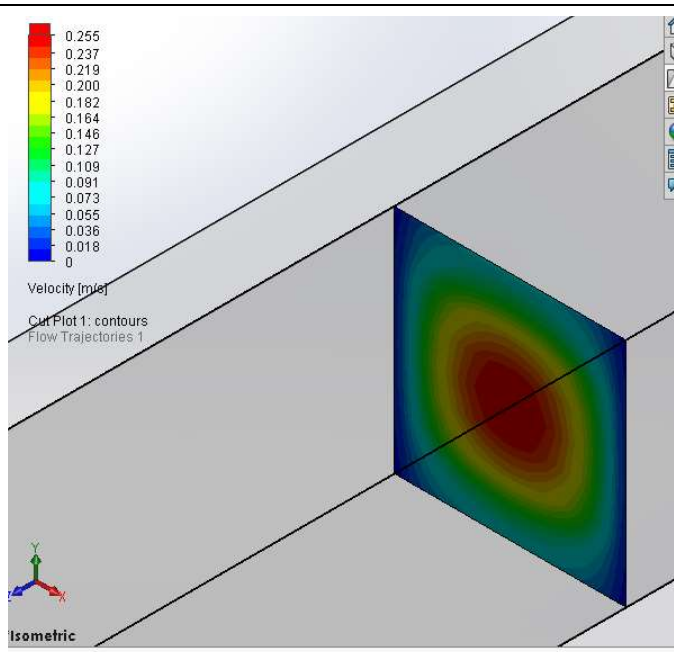


Figure 6: Goal Plot from Step 56.

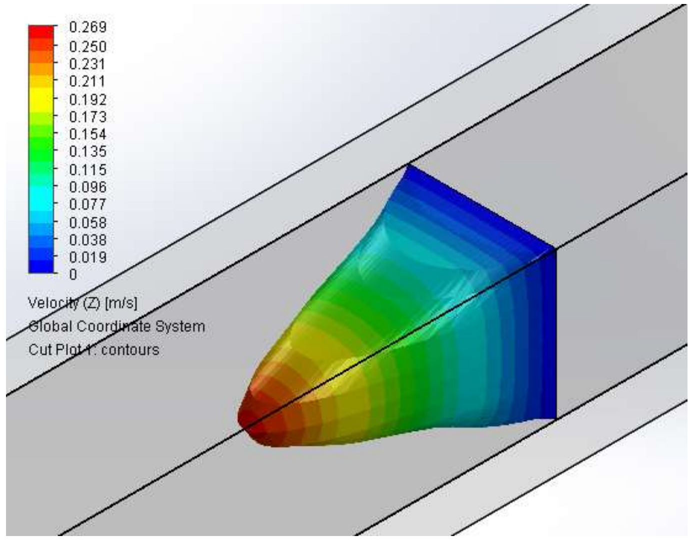
7. Insert screenshots of your 2-D velocity contour cut plot at z = -0.010 m from step 59 below:



Light bulb did not show up and geometry was off

Figure 7: 2-D Velocity Contour Cut Plot from Step 59.

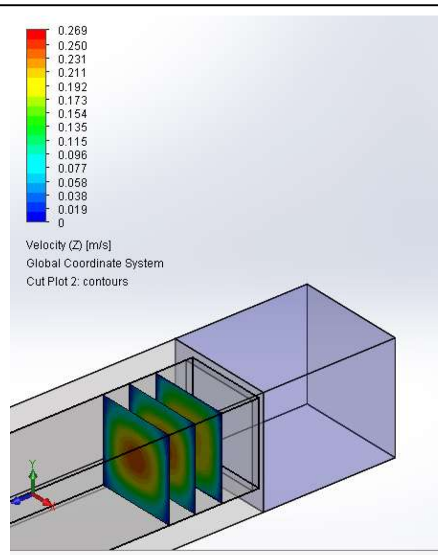
8. Insert a screenshot of your 3-D Velocity Contour from step 60 below:



Lightbulb and geometry

Figure 8: 3-D Velocity Contour from Step 60.

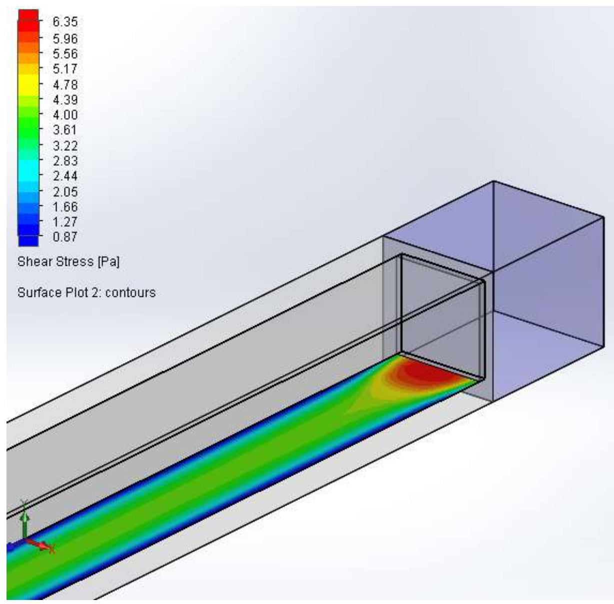
9. Insert one screenshot showing all 3 contour plots near entrance with z offsets of -0.01230m, -0.01240m, -0.01250m from step 62 below.



Lightbulb and geometry so I had to guess offsets

Figure 9: all 3 Contour Plots Near Entrance.

10. Insert a screenshot of your Sheer Stress Contours from step 65 below:



lightbulb

Figure 10: Sheer Stress Contour from Step 65.

11. Discuss the flow profiles you achieved in this part of the lab. Are the results similar to what you would expect based on your knowledge of fluid mechanics? Why or why not? Consider laminar vs. turbulent flow, the no-slip condition, as well as any other concepts you think are important.

    The flow profiles that were achieved in this lab were one, multiple, top views. The results were similar to what would be expected due to the gradient of pressure and velocity increasing from the outside inward. This could be seen through the change in colors of the flow profiles from blue to red. Laminar flow would needed to be used in order to see these flow profiles to allow for the flow profiles to be predictable since turbulent flow is not. The no-slip condition is violated in these flow profiles due to the flow moving on the boundary layers.

12. Discuss the differences you see between the results of the coarse and fine meshes. How do the flow velocities and profiles compare? Which mesh seems to do a better job of replicating the flow profile we would expect in the channel? (What known condition does one of the meshes violate, based on the flow profile produced?)

    With the more coarse meshes, the no-slip condition and velocities on the wall do not appear to be zero. The finer meshes allowed for these to be fulfilled and the flow can be properly represented. The flow velocity contour profiles can be better seen through the finer mesh due to its more detailed change in velocity data points.

13. Based on the results from this part of the lab, how important is establishing a quality mesh before running your flow simulation? What could happen if the mesh is too coarse? What drawbacks might be present when using a fine mesh compared to a coarse mesh?

    It is very important to establish a quality mesh before running a flow simulation because it ensures a more accurate representation of the flow profiles. If the mesh is too coarse, then the no-slip condition will be violated and the velocities on the channel walls will appear to not be zero. A drawback of the finer mesh would be that the calculations would take longer since more are needed to be made.

14. After completing this part of the lab, how do you plan to assign a proper mesh for your custom chip design?

    For a proper mesh of the chip design, a fine mesh must be made that shows that the no-slip condition is fulfilled and the velocities of the channel wall are zero. Also, for the mesh, a the velocities, pressure, and sheer stress must be represented through contour flow profiles.

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- Once you have completed APP N06-1.2, save it, combine it with APP N06-1.1, add a cover page to create APP N06-1.
- Convert APP N06-1 to a PDF and submit to Carmen according to the DAL.

15. Insert screen shot of your mesh below:

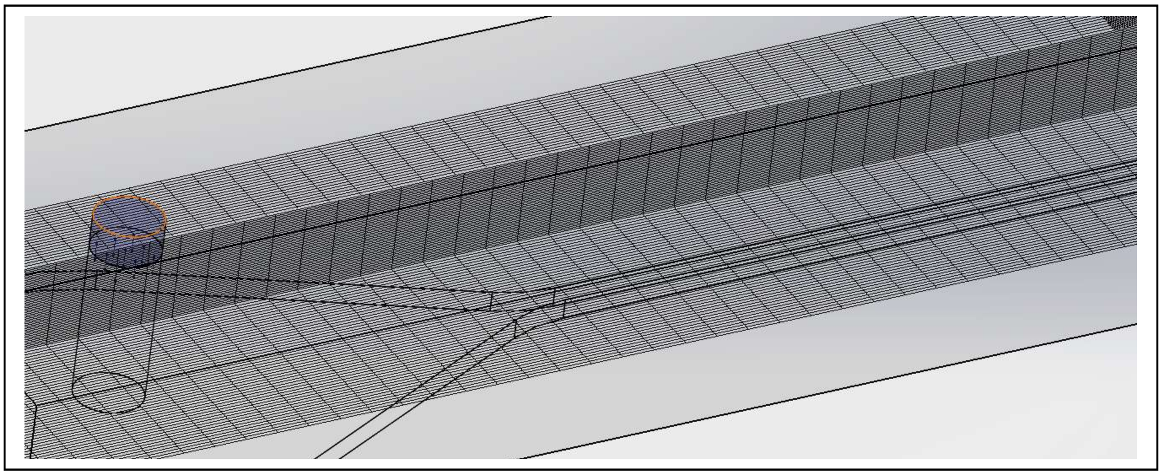

Figure 5: Mesh of Complex Channel

16. Insert screen shot of your goals plot below:

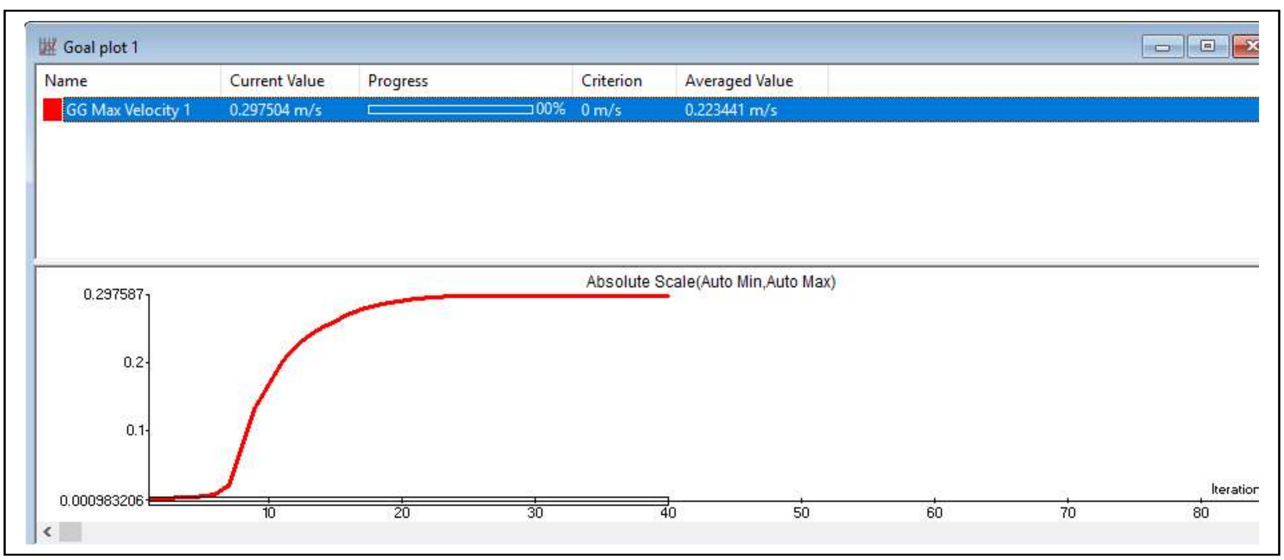

Figure 6: Goal Plot of Max Velocity

17. Complete the table below with the results from your flow simulation:

Table 1: Caption goes here.

Parameter	Value
Max Velocity	0.297504 m/s
Delta (over last 5 iterations)	5.37083 e^-05
Average Velocity	0.223441 m/s
Max Shear Stress	4.73 Pa

18. Insert screen shot of your Velocity Simulation (flow trajectories) below:

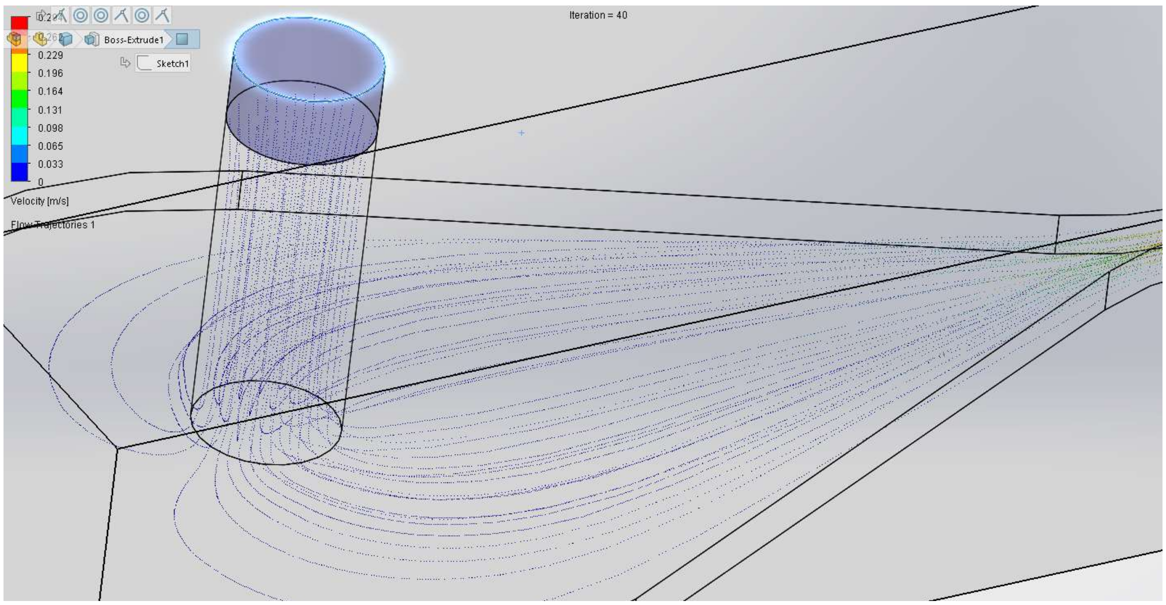

Figure 7: Flow Trajectory

19. Insert a screen shot of your Velocity Contours (lateral) below:

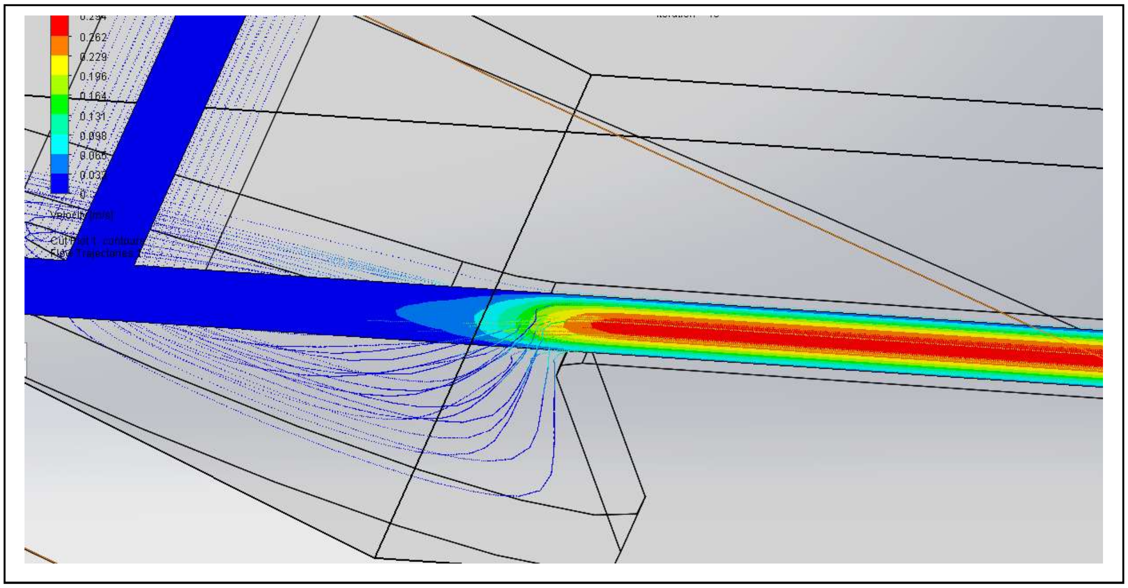

Figure 8: Lateral Velocity Contour

20. Insert a screen shot of your Velocity Contours (transverse) below:

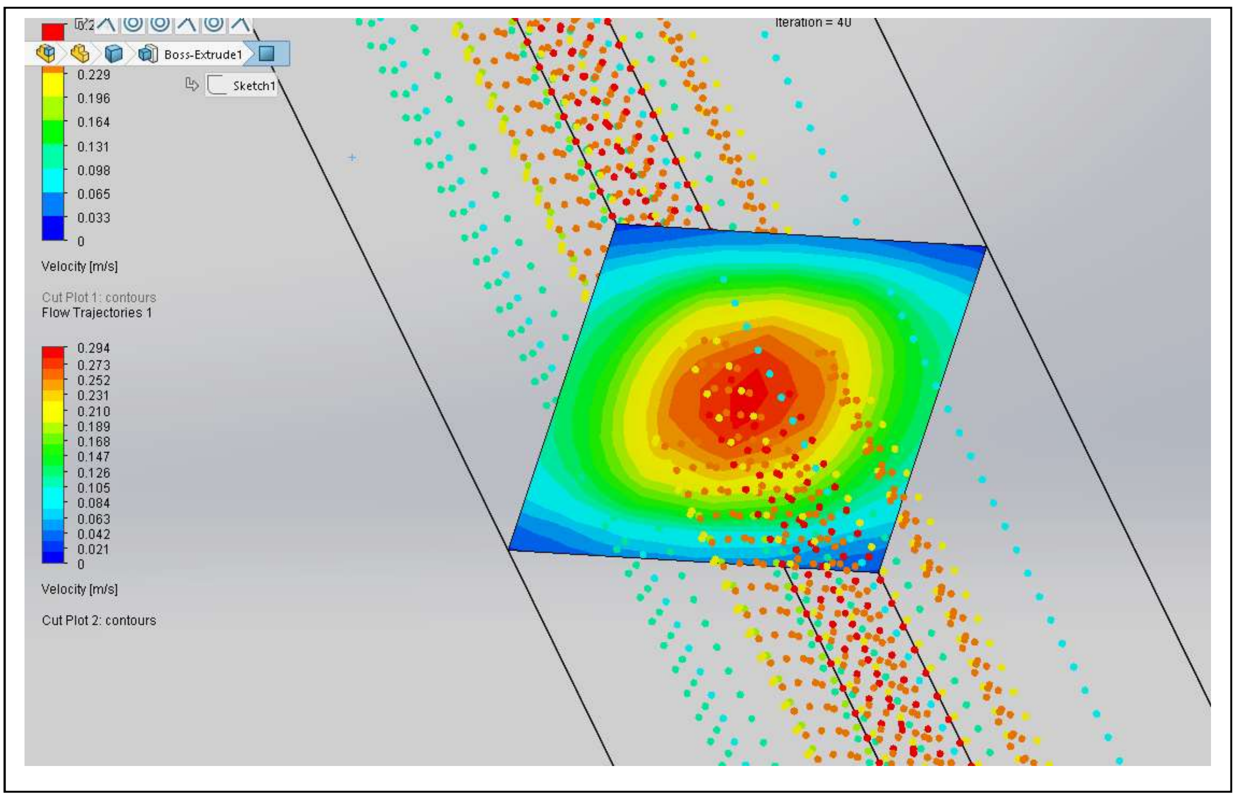

Figure 9: Transverse Velocity Contours

21. Insert a screen shot of your Pressure Contour below:

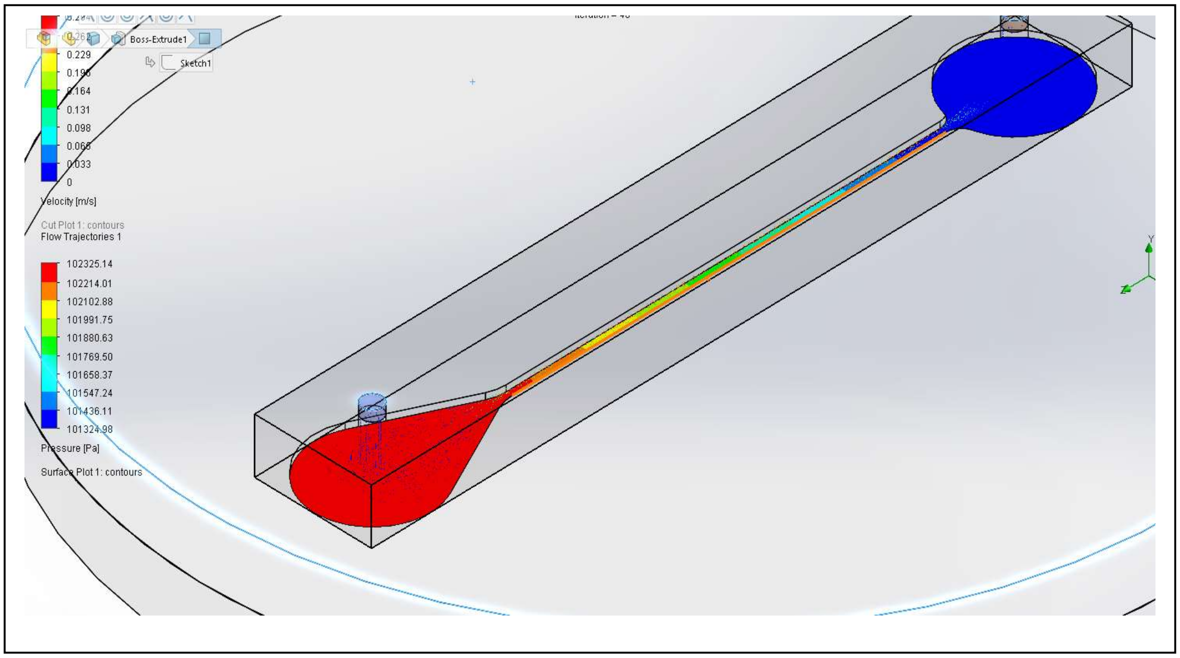

Figure 10: Pressure Contour

22. Insert a screen shot of your Sheer Stress Contours below:

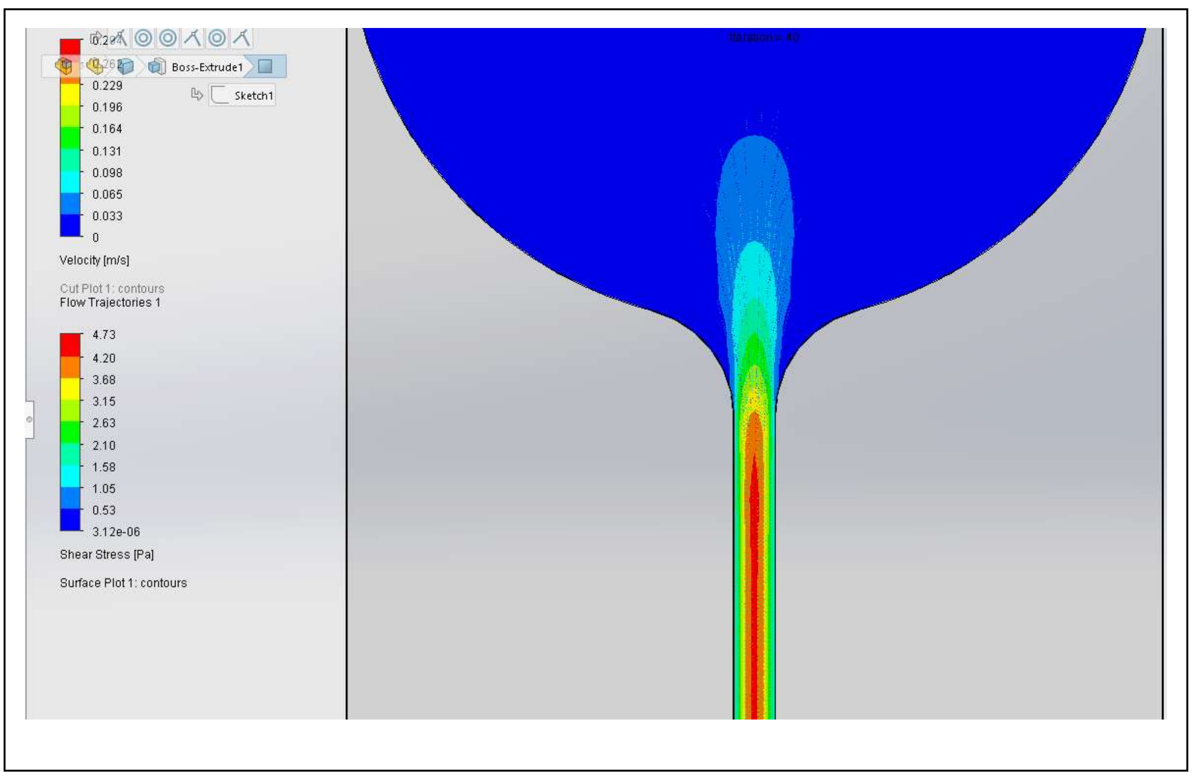

Figure 11: Shear Stress Contours

Use your fluid mechanics program to simulate the flow simulation performed in this part of the lab. The dimensions of the **complex** channel you used for this part of the lab are below:

Length	22.30 mm
Width	0.33 mm
Height	0.13 mm

Below are the flow parameters:

Pressure Head (ΔP)	1000 Pa
Dynamic Viscosity (μ)	0.0010014 Pa·s
Density (ρ)	998.16 kg/m^3

Fill out the table below with the results of the SolidWorks flow simulation (from question 3) and the results from the fluid mechanics program:

Table 2: SolidWorks and Program Results of Average Velocity and Max Shear Stress

Parameter	SolidWorks	Fluid Mechanics Program
Average Velocity	0.223441 m/s	0.63065 m/s
Max Shear Stress	4.73 Pa	2.9147 Pa

How do the two results compare? What discrepancies, if any, are present? Use your knowledge of the assumptions of both simulations to think of potential causes of any differences.

The results are different between each value. These differences can be seen because both are theoretical channels. While both show that at the walls of the channels, the velocities is not zero and therefore ensuring that the no-slip condition is not violated, they have different velocities at the walls. The SolidWorks can also be taking into account turbulent flow and that explains why the shear stress is higher.

23. Briefly discuss what each of the following plots shows you in regards to the flow in the channel simulation. Your discussion of each plot should indicate your understanding of the basic fluid mechanics principles we've learned in class. Be sure to address why the contours can change near the walls of the channel, where applicable.

Lateral velocity contours:
The lateral velocity contours show how the flow velocity decreases as the fluid approaches the edge of the channel and shows the no-slip condition with the velocity being zero at the very edge.

Transverse velocity contours:
The transverse velocity contour similarly shows the decrease in velocity as the fluid moves away from the center and shows the no-slip condition but gives a view of the entire channel versus just a view of velocity laterally.

Pressure contour:
The pressure contour shows the increase in pressure over the channel length due to the difference in pressure at the inlet and outlet of the channel.

Shear stress contour:
The shear stress contour shows the decrease of the shear stress away from the center of the channel which is due to the decrease of velocity.

24. What effect, if any, do the inlet and outlet areas have on the flow? What does this tell you about the importance of entrance length? How will this affect your chip design and/or experimental procedure? Reference any corresponding figures which support your claim.

The inlet area has some effect on flow while the outlet area does not, however the effect of the inlet area is not incredibly significant. The flow in the inlet area is very slow based on the flow trajectory which is good because it minimizes the effect of the area. This means that the inlet area should be large in comparison to the channel size.