APP N06_1

AJ Senthilkumar

Engr 1282.02 SP20

M.Parke 12:40

2.24.20

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:

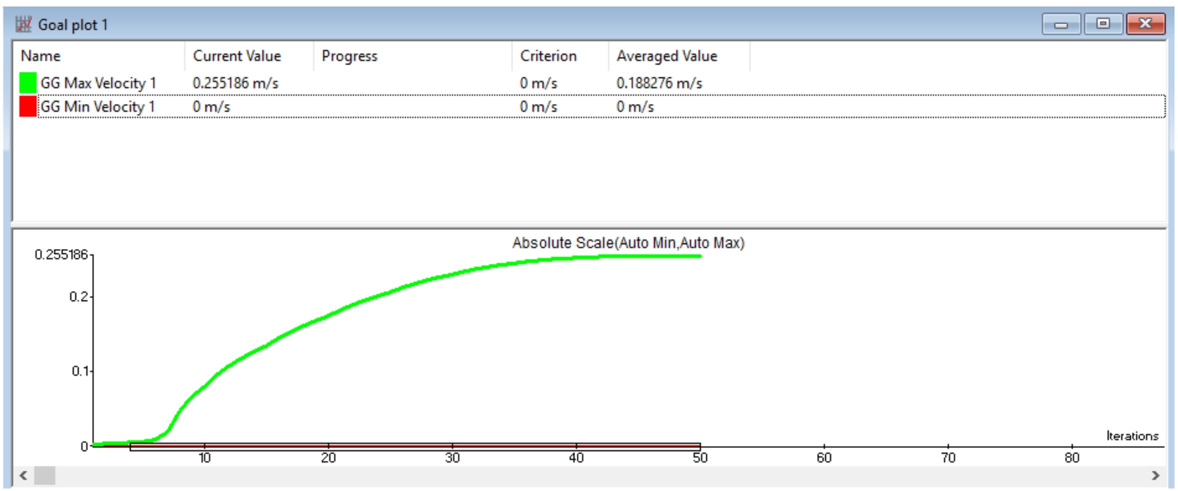

Figure 1: Plot of Max and Min Velocities

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

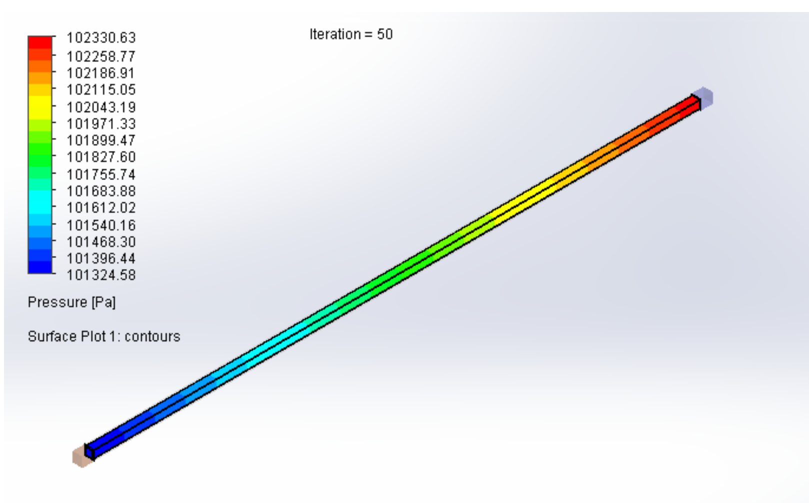

Figure 2: Pressure Contour Plot

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

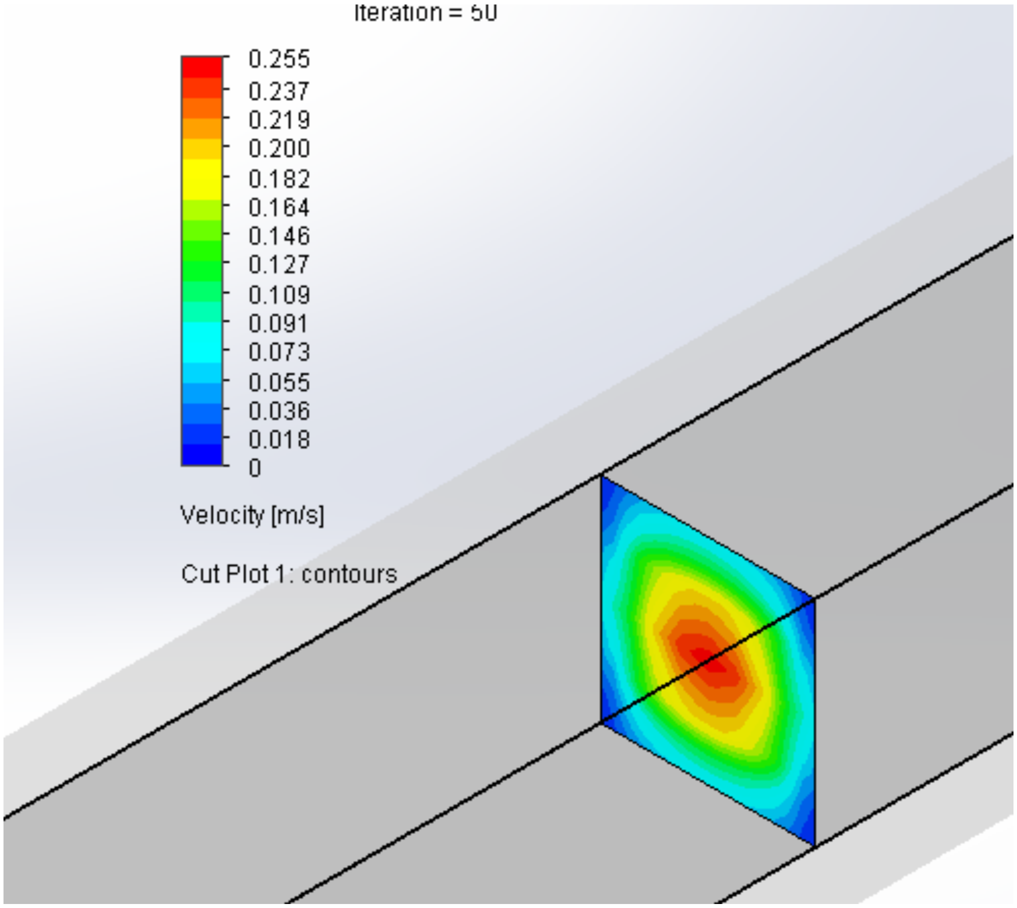

Figure 3: Velocity Contour Cut Plot

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

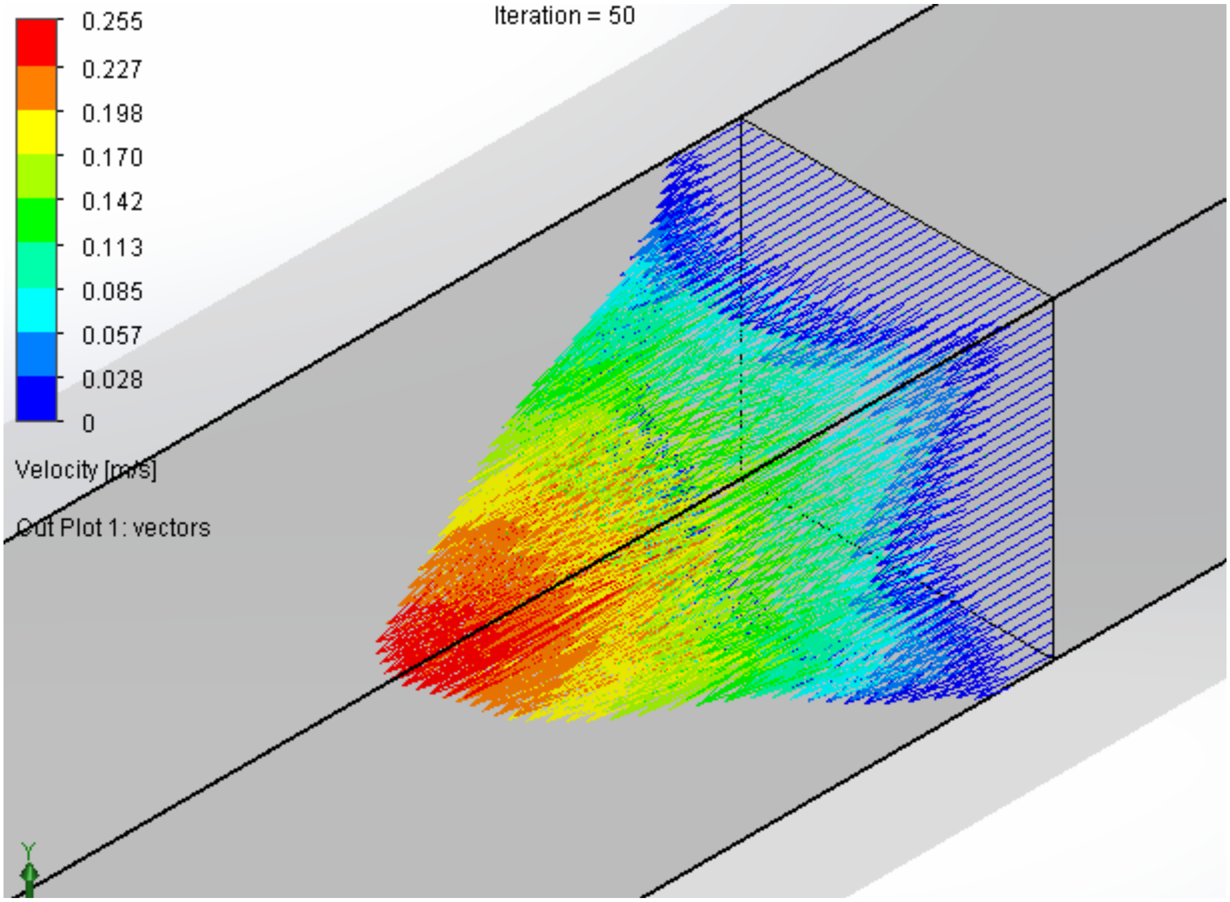

Figure 4: Velocity Vectors at z=-0.10m

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

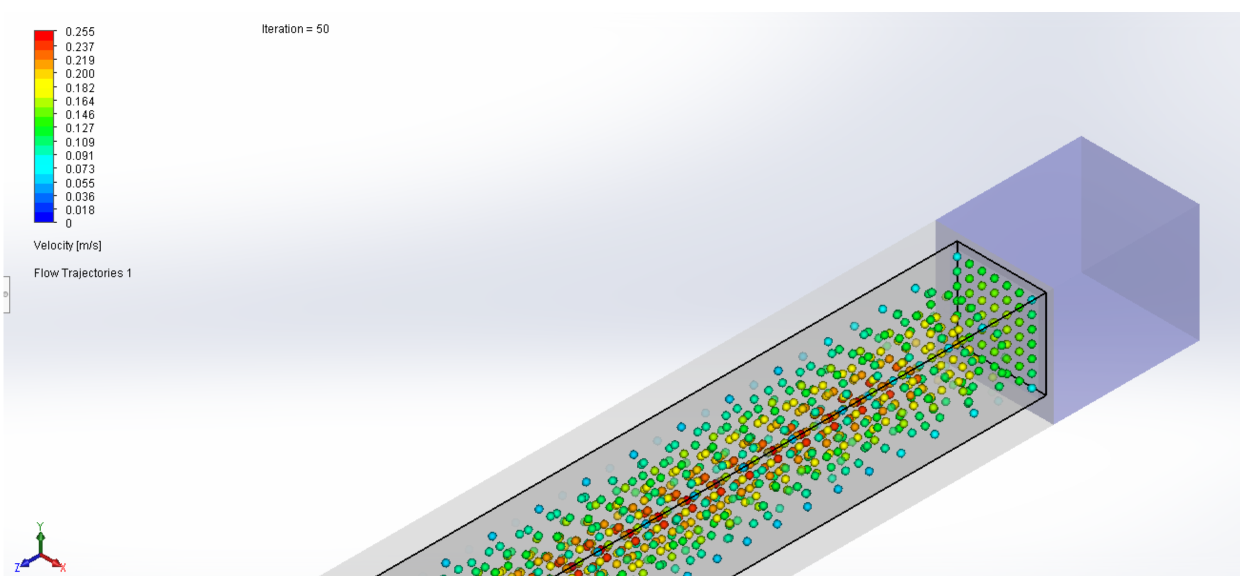

Figure 5: Flow Trajectories

Fine Mesh:

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

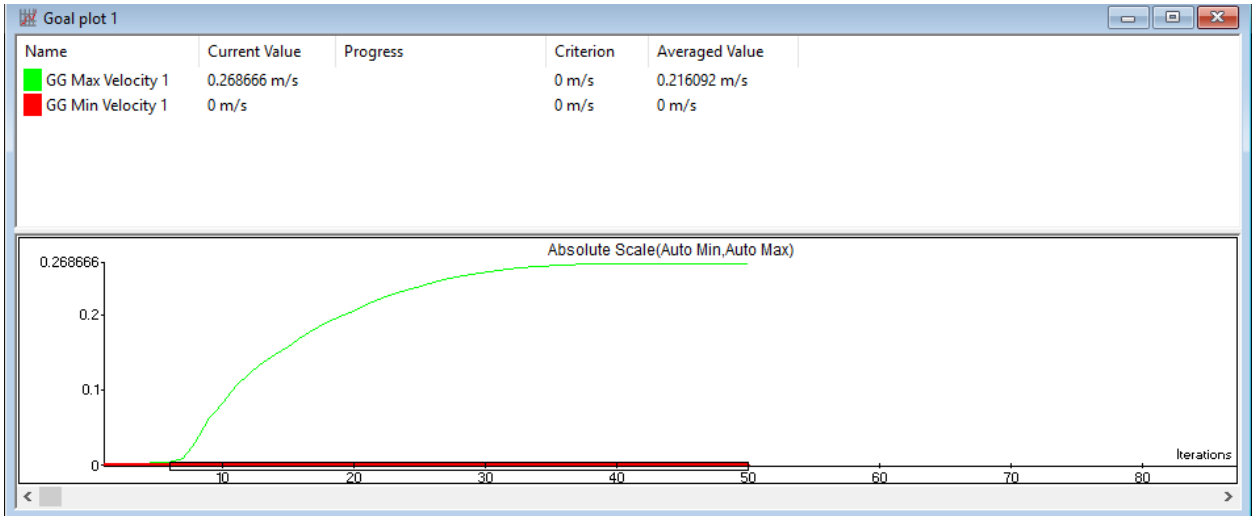

Figure 6: Goals Plot

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

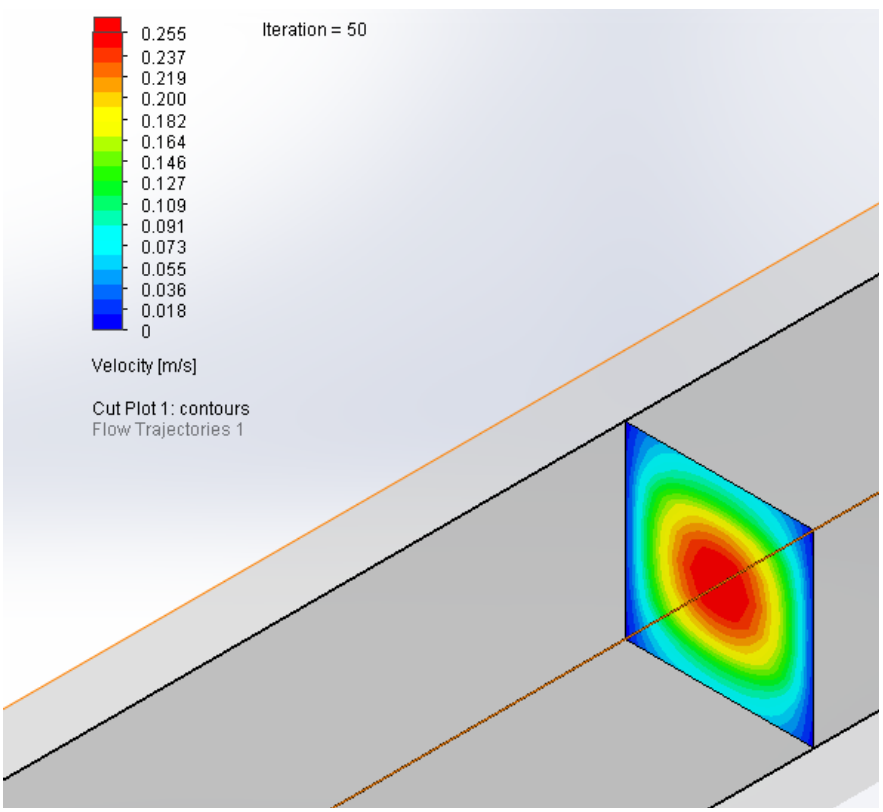

Figure 7: Velocity Contour Cut Plot

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

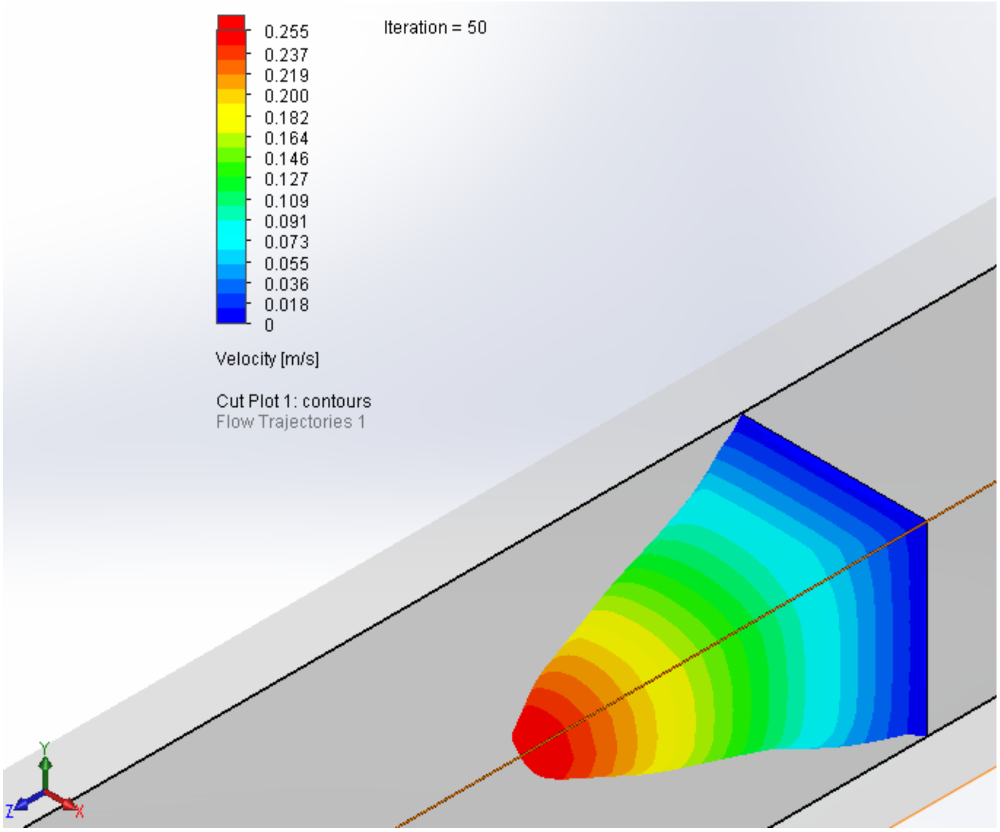

Figure 8: Velocity Contour (3-D)

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.

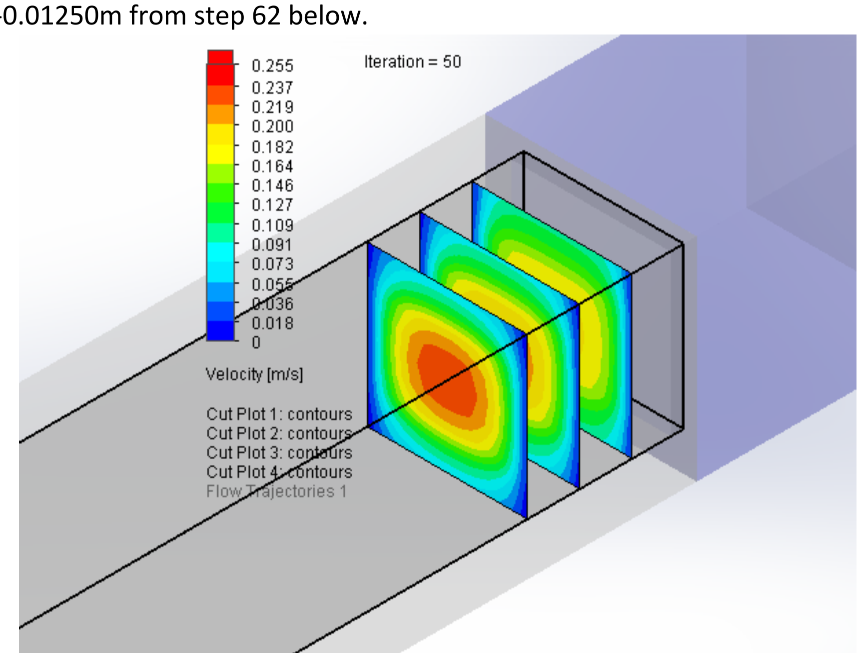

Figure 9: Velocity Cut Contour Plots

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

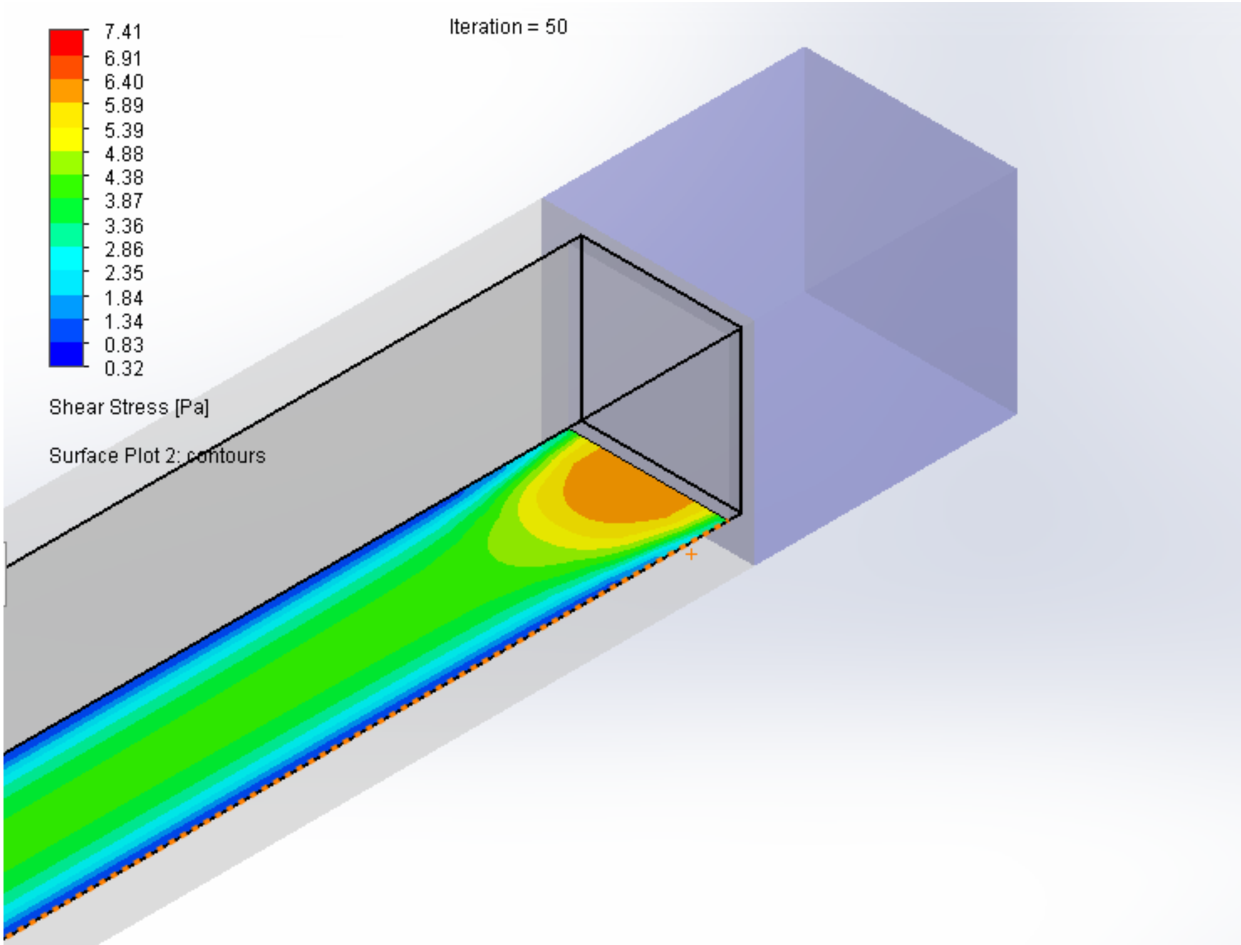

Figure 10: Shear Stress

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.

In this part of the lab, the conditions were steady state so the flow was intended to be laminar. Because the velocities, pressure types, and fluid types were kept at a constant level, it works as intended. The flow is laminar so it is not acting abnormally.

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?)

The velocity was higher for the fine mesh and can be seen in the cut plots. The velocity transitions better in the coarse mesh, this can be seen in the concentric nature of the colored circles of the cut plot. The fine mesh produces a better representation because the coarse mesh is too coarse and violates some physical properties.

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?

The wrong mesh can impact the velocity representation. The plot is necessary to show the flow throughout the channel and a finer mesh can be more representative of that. This is important to know because the wrong mesh can impact your results and therefore your conclusions from the lab.

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

Multiple iterations will definitely be required because the mesh will vary based on different qualities. I am assuming, based on this lab, that the mesh will be finer.

APP N06_1.2
AJ Senthilkumar and Sean Sullivan
ENGR 1282.02 SP20

M.Parke 12:40
02.24.20

INSTRUCTIONS:

- Complete this worksheet as you follow APP N06-1.2 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
- 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:

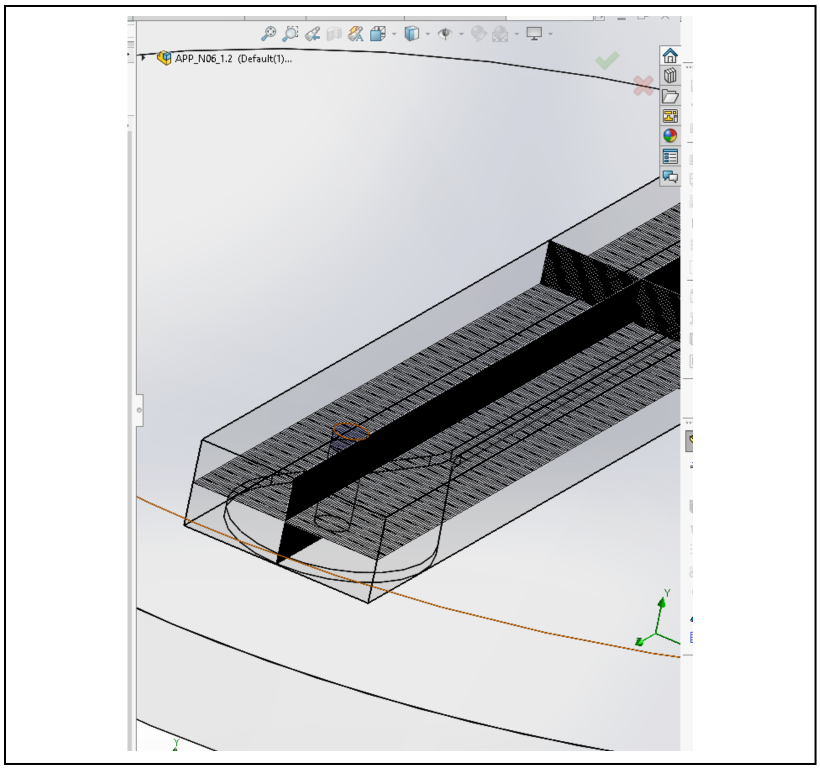

Figure 5: Mesh

16. Insert screen shot of your goals plot below:

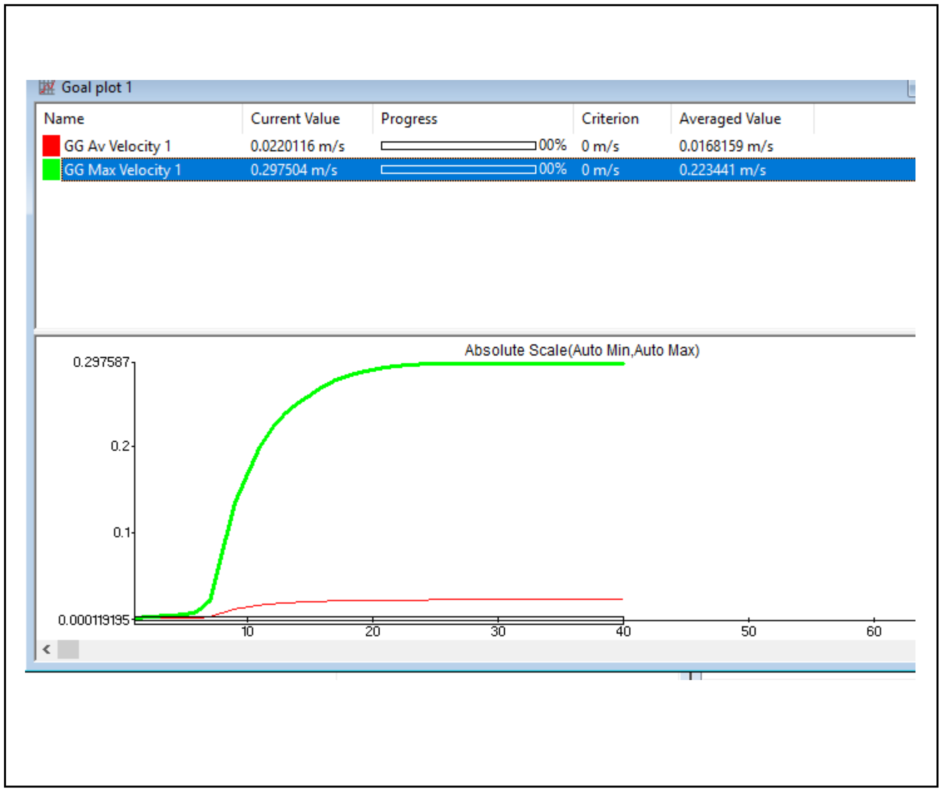

Figure 6: Goals Plot

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

Table 1: Flow Simulation Results

Parameter	**Value**
Max Velocity	..297558
Delta (over last 5 iterations)	5.37083e^5
Average Velocity	.297531
Max Shear Stress	4.73

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

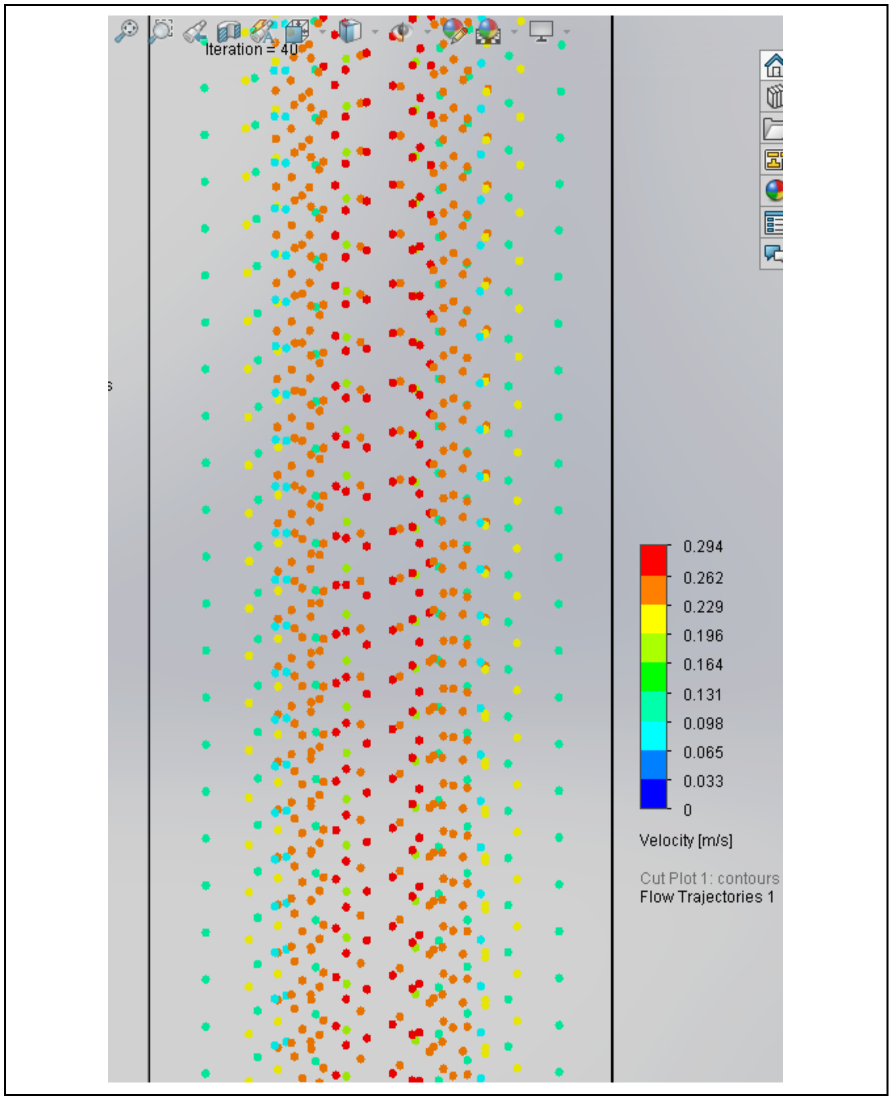

Figure 7: Flow Trajectories from the lab simulation.

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

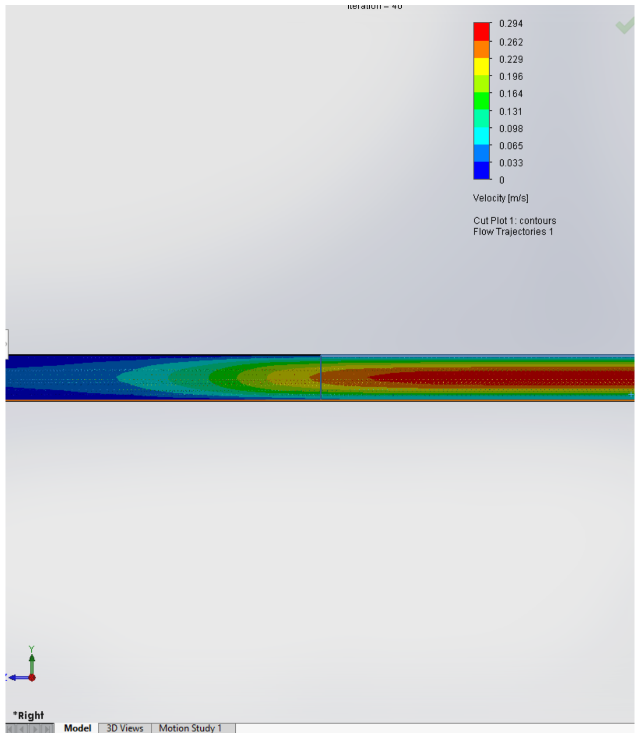

Figure 8: Lateral velocity contours.

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

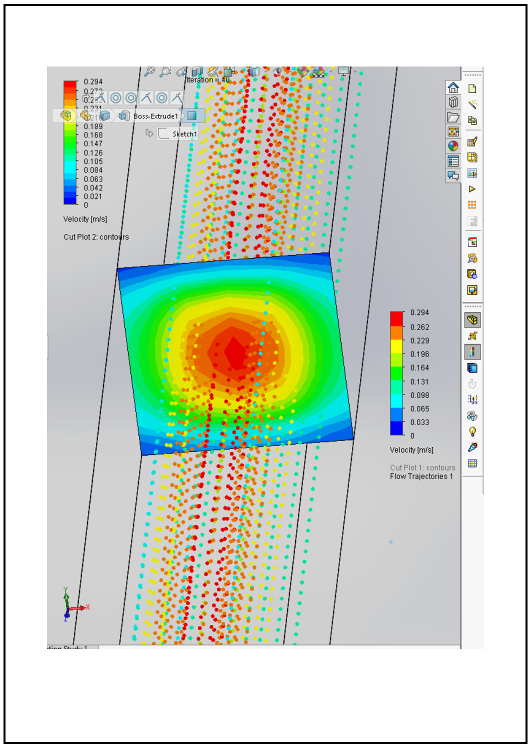

Figure 9: Transverse velocity contours.

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

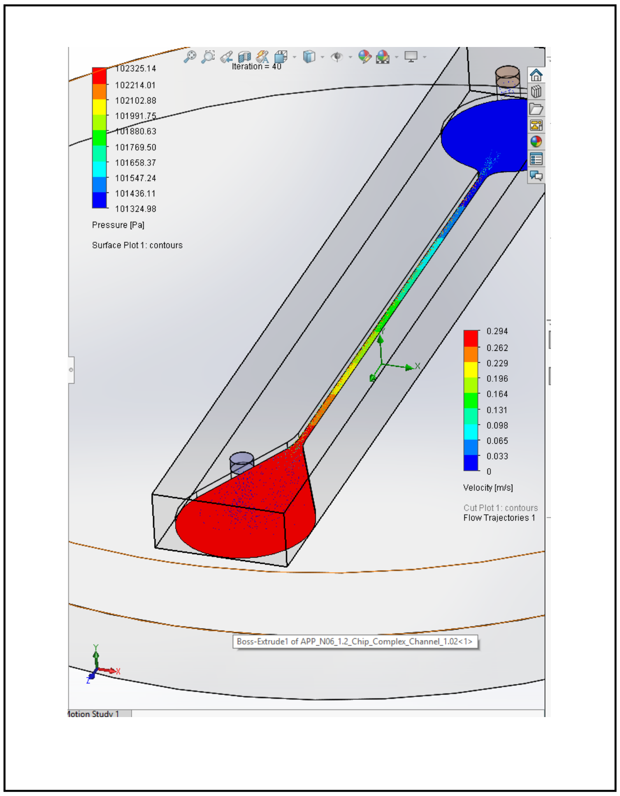

Figure 10: Pressure contours.

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

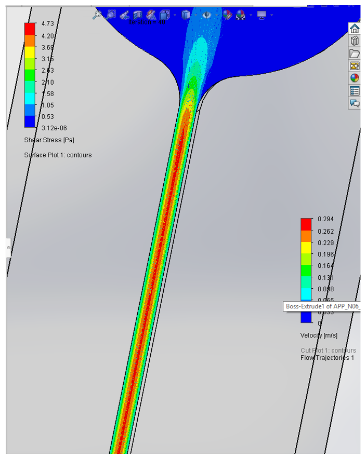

Figure 11: Sheer stress contours.

23. 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: Caption goes here.

Parameter	SolidWorks	Fluid Mechanics Program
Average Velocity	.297531	.630657
Max Shear Stress	4.73	2.9148

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 program varied widely from the simulated values. The Solidworks simulation was probably more accurate than the set equations that were used for solving. Solidworks used several iterations of a simulation, which likely gave results that were closer to reality than the calculations from the program.

24. **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: These show the velocity taken from a cross-sectional view of the channel. They show the velocity as it passes through the cross section.

Transverse velocity contours: These contours effectively model large, individual molecules, as they show the velocity at their location in the channel.

Pressure contour: This plots the pressure measurements of the liquid at various points in the channel. It shows the pressure as it would be seen from the very base of the channel.

Shear stress contour:

25. **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.**
    Inlet length has a marked effect on the flow of liquid through the channel, as it has the highest pressure and therefore greatest capability of allowing the liquid to move. The outlet length has less of an effect on flow as the pressure is lowest at its end, so there are fewer water molecules to benefit from more area to move. Figures 6 and 7 support this statement as they illustrate the gradient between pressure at the inlet and the pressure at the outlet.