COMPUTER PROJECT

ME/AE 5212 Introduction to Finite Element Analysis

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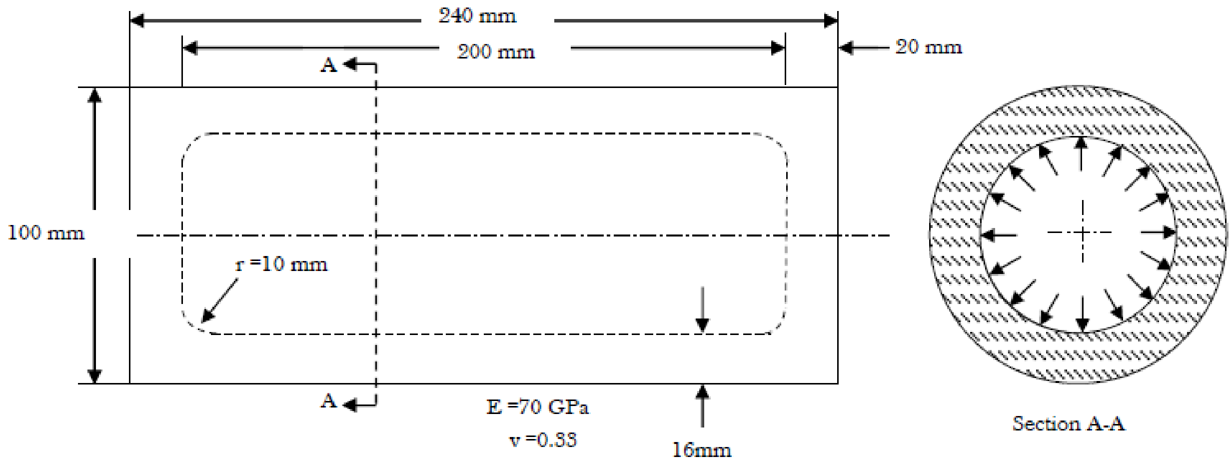
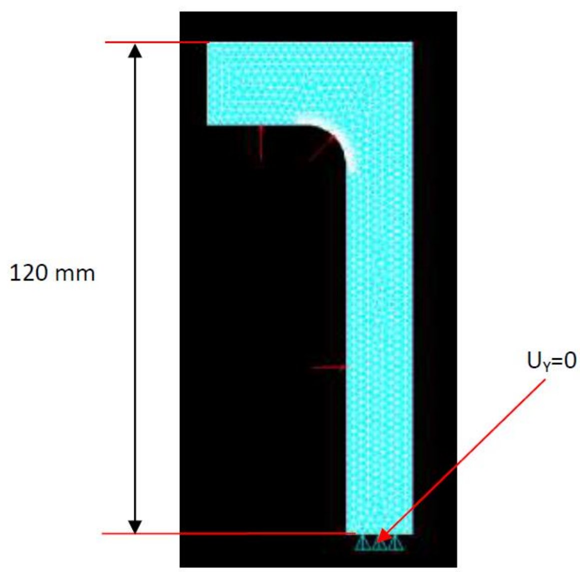
1. Consider the cylindrical closed vessel under uniform internal pressure. Find the maximum pressure it can withstand. Plot the deformed configuration and von-Mises stress distribution in the walls of the closed cylinder. Use a factor of safety of 2 and yield strength for aluminum as 95 MPa. Use 8-node quadratic axisymmetric element (Solid Quad 8 node 183).



Solution:

The triangular mesh size is 0.001.

Using half axisymmetric modeling, the boundary condition and applied load are shown in the following figure.



The maximum von-Mises stress should satisfy the following equation,

$$\sigma_v \leq \frac{\sigma_{yield}}{Factor\ of\ Safety} = \frac{95\ e6}{2} = 47.5\ e6$$

The maximum pressure it can withstand can be obtained by using trial and error method. The process is shown in the following table.

	Applied pressure (Pa)	Maximum von-Mises stress (Pa)
Case 1	47.5 e6	234 e6
Case 2	10 e6	42.730 e6
Case 3	11 e6	47.003 e6
Case 4	11.2 e6	47.858 e6
Case 5	11.1 e6	47.430 e6
Case 6	11.12 e6	47.516 e6
Case 7	**11.116 e6**	**47.499 e6**

In case 7, the maximum pressure is obtained,

P_{max} = 11.116 MPa

And the maximum and minimum values are shown below.

NODE	S1	S2	S3	SINT	SEQV
MINIMUM VALUES					
NODE	102	102	102	154	154
VALUE	-0.11129E+09	-0.12381E+09	-0.12395E+09	0.57185E+07	0.52369E+07
MAXIMUM VALUES					
NODE	210	2	8046	210	210
VALUE	0.43812E+09	0.22925E+09	0.83671E+07	0.54824E+09	0.47499E+09

The deformed configuration and von-Mises stress distribution in the walls of the closed cylinder are shown in the following figures.

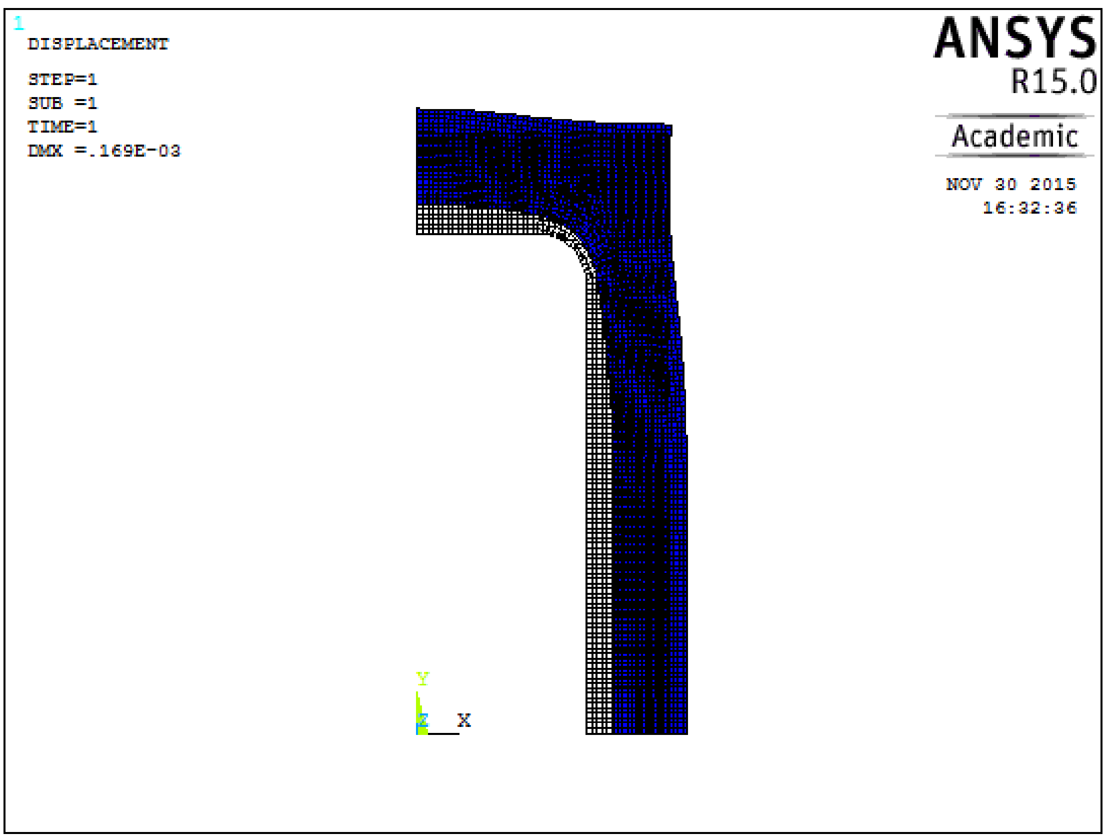


Fig. 1 Deformed configuration

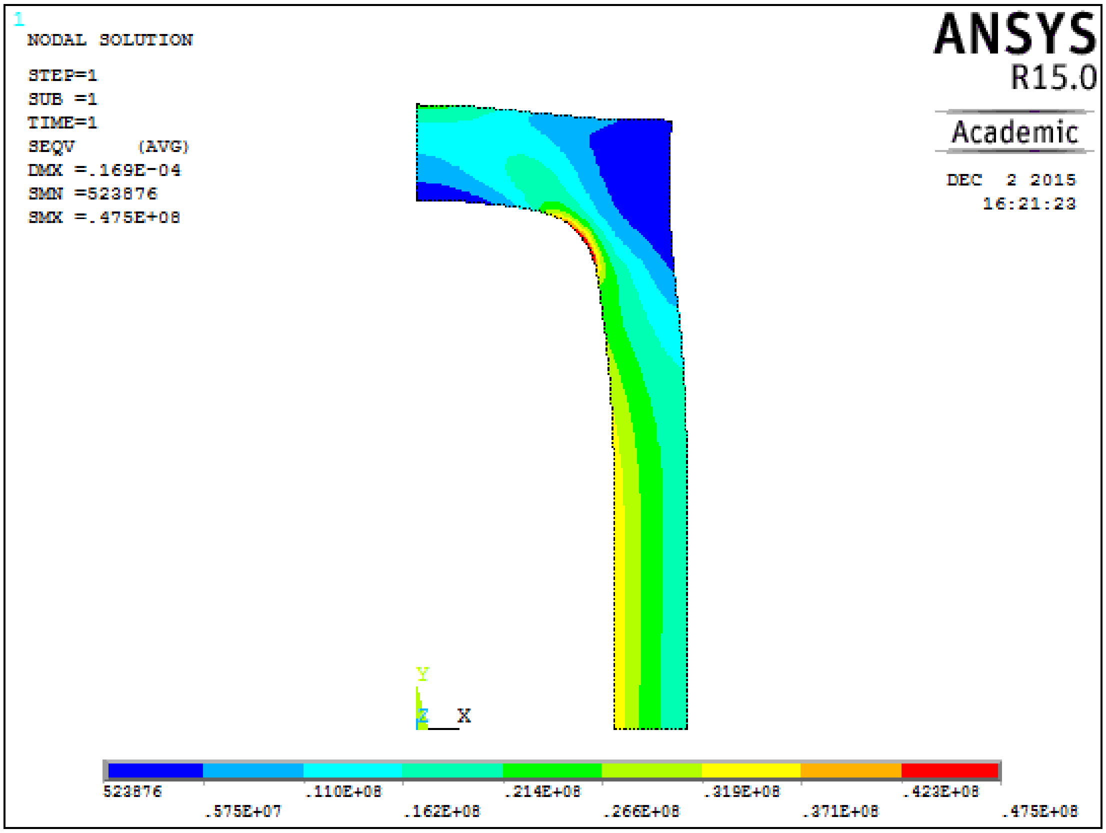
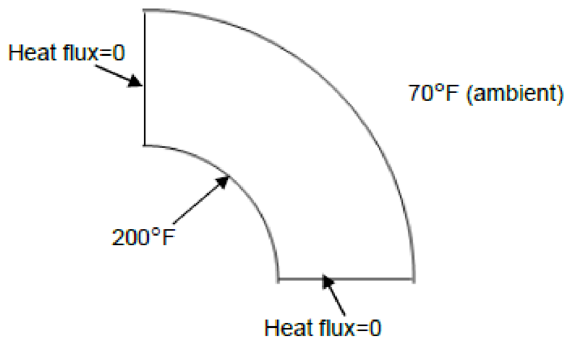


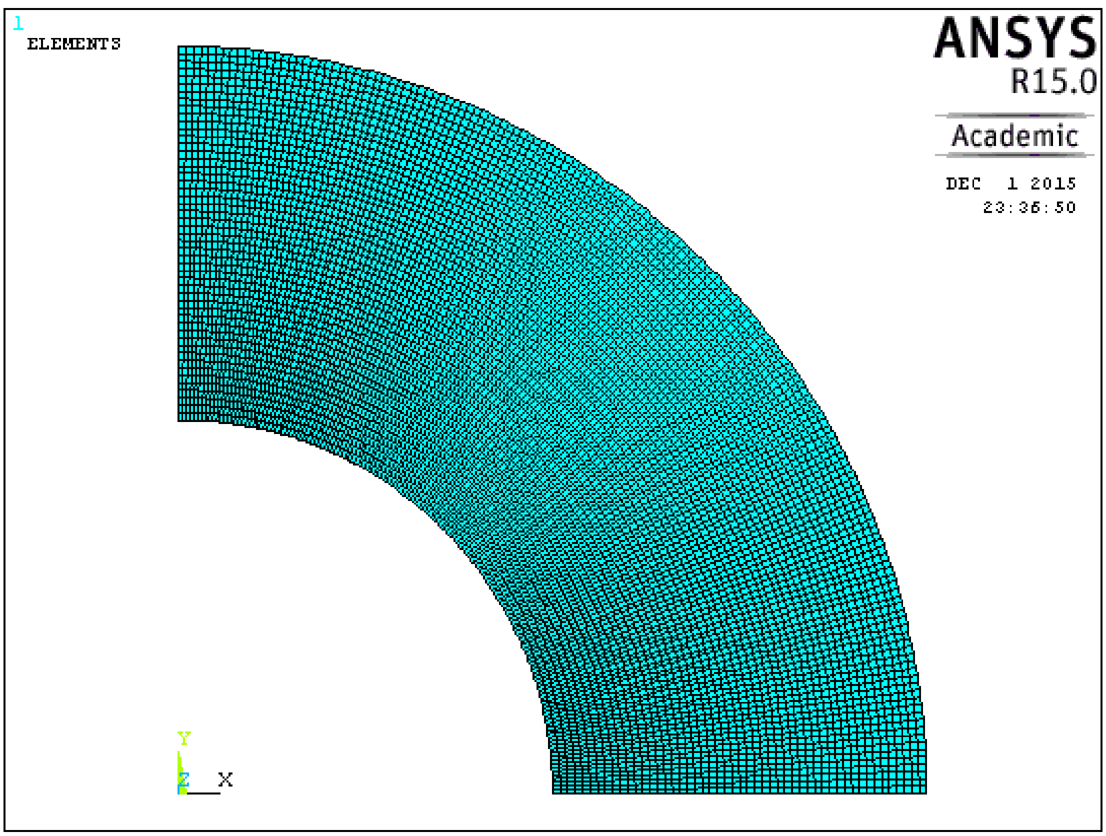
Fig. 2 von Mises stress of the nodal solution

2. Consider a long steel cylinder with inner radius 5 in. and outer radius 10 in. The interior of the cylinder is kept at 200°F, and heat is lost on the exterior by convection to a fluid whose temperature is 70°F. The convection coefficient is 5×10^{-4} BTU/sec-in^2-°F and the thermal conductivity for steel is taken to be 8.09×10^{-4} BTU/sec-in-°F. Recognizing the symmetry of the problem, a quarter of a section through the cylinder is modeled. Use 4-node quadrilateral element (Quad 4 node 55). Find the minimum temperature on the exterior surface. Plot the contour plot of temperature distribution.



Solution:

The Mesh size is 0.1. And the mesh configuration is shown below.



The temperature distribution of the section is shown in the following figure.

The minimum temperature on the exterior surface is,

***T*$_{min}$ = 94.6033 °F**

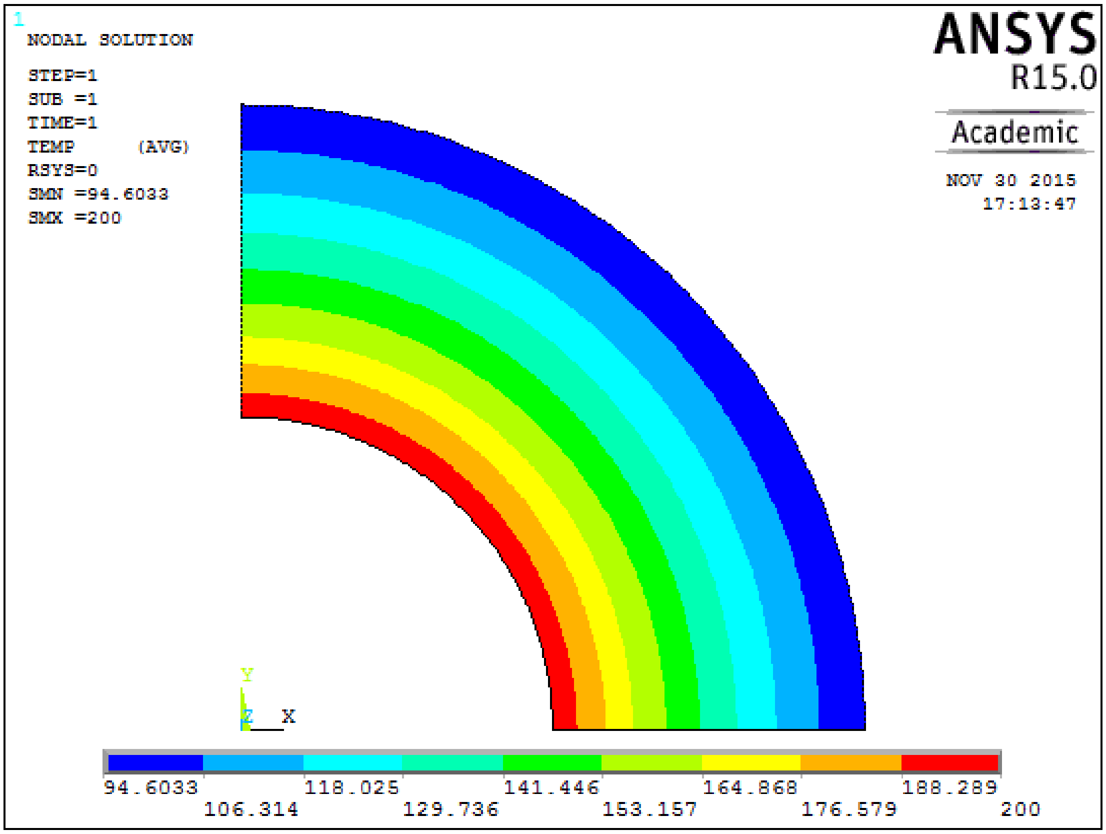
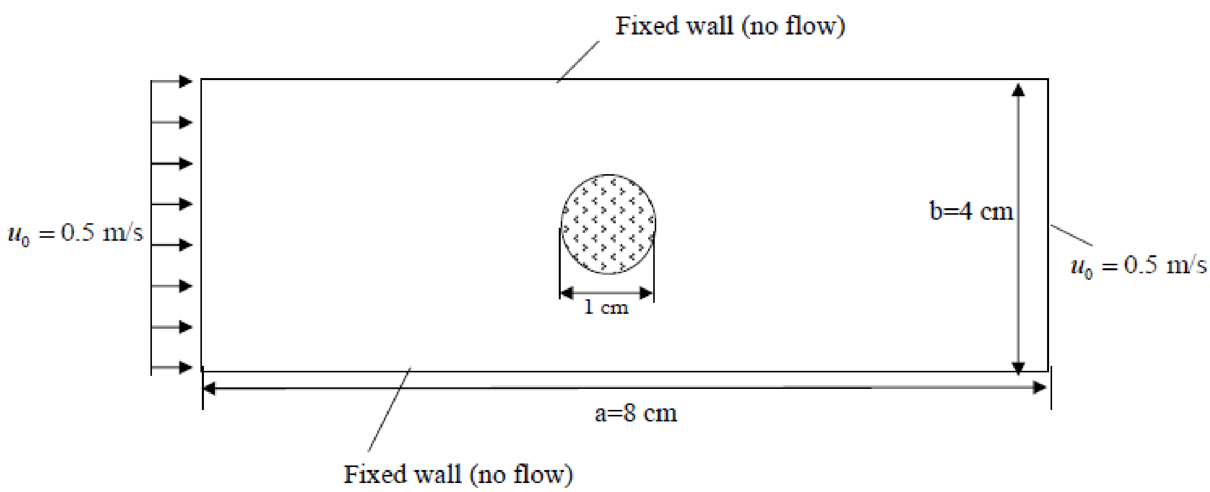


Fig. 3 Temperature distribution

3. Solve the problem of the flow around a solid cylinder at the center of the plate. The geometry and boundary conditions are shown in the figure. Use triangular element. Find the maximum velocity and maximum pressure. Plot the contour of velocity distribution and pressure distribution. Use air as the fluid material flowing through the plate. Refer to the fluid mechanics problem in ANSYS handout.



Solution:

The mesh and boundary conditions are set as shown in the following figure.

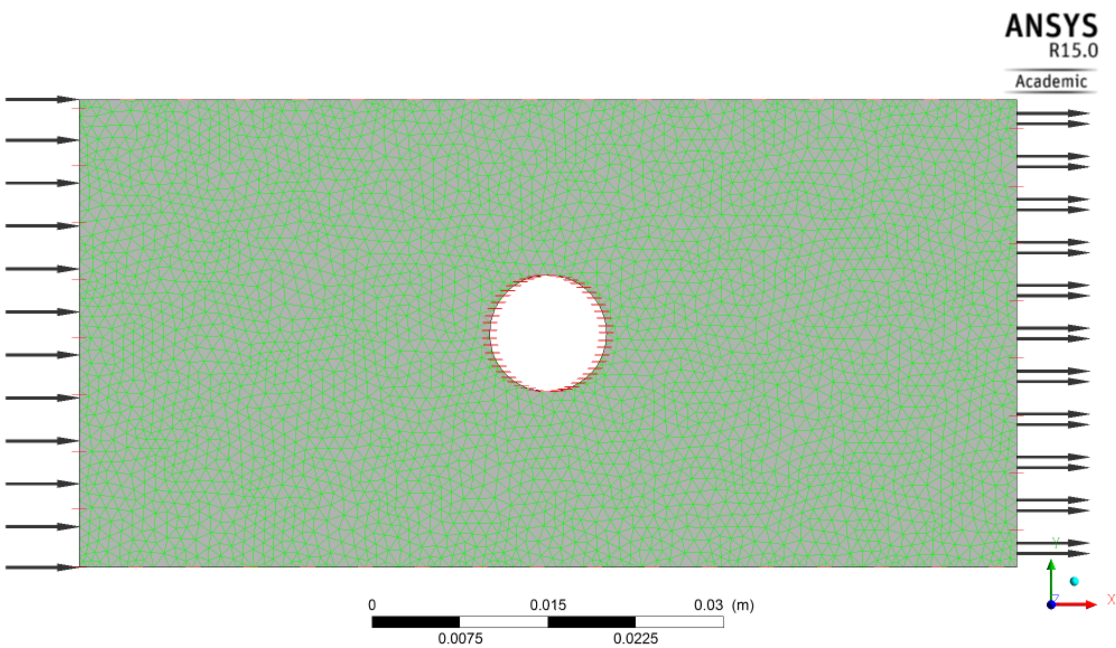


Fig. 4 Mesh and boundary conditions

The ***maximum velocity*** is 0.819439 m/s which occurs at the upper side and lower side of the cylinder as shown in figure 5 and figure 6.

The ***maximum pressure*** is 0.103143 Pa which occurs at the left side of the cylinder against the flow direction, where the air flow is being compressed (figure 7).

The contour of velocity distribution and pressure distribution are as described in the following figures.

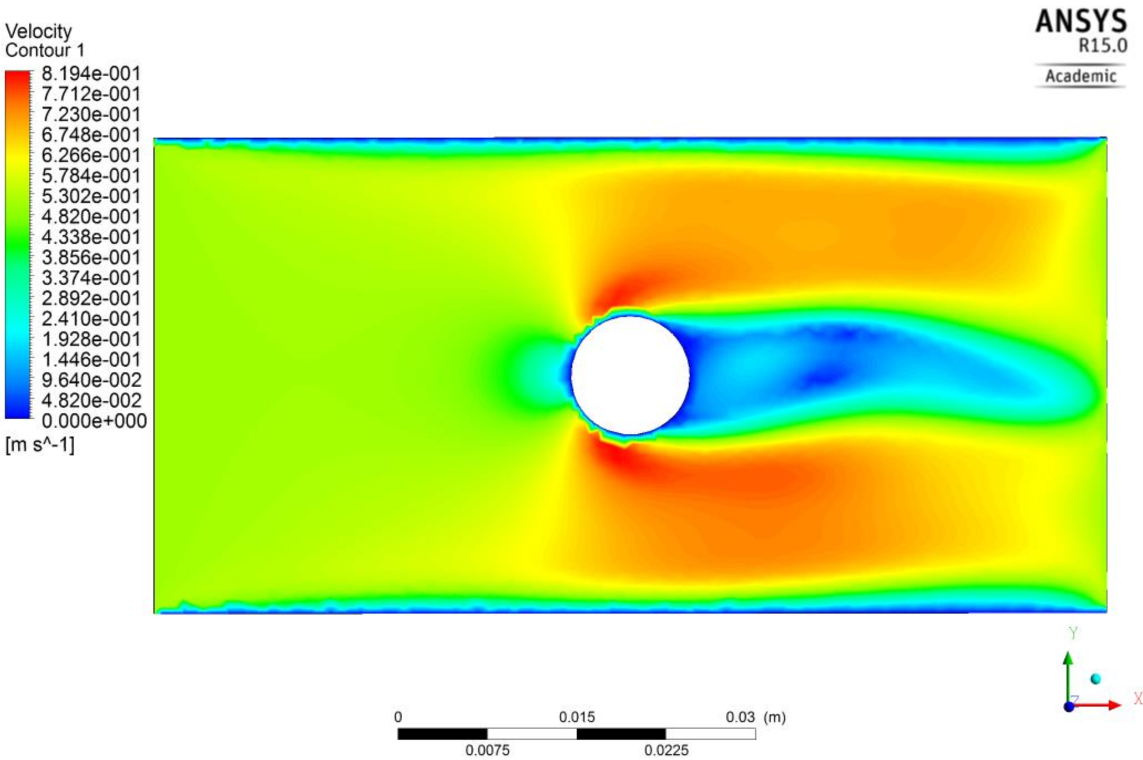


Fig. 5 Contour of velocity distribution

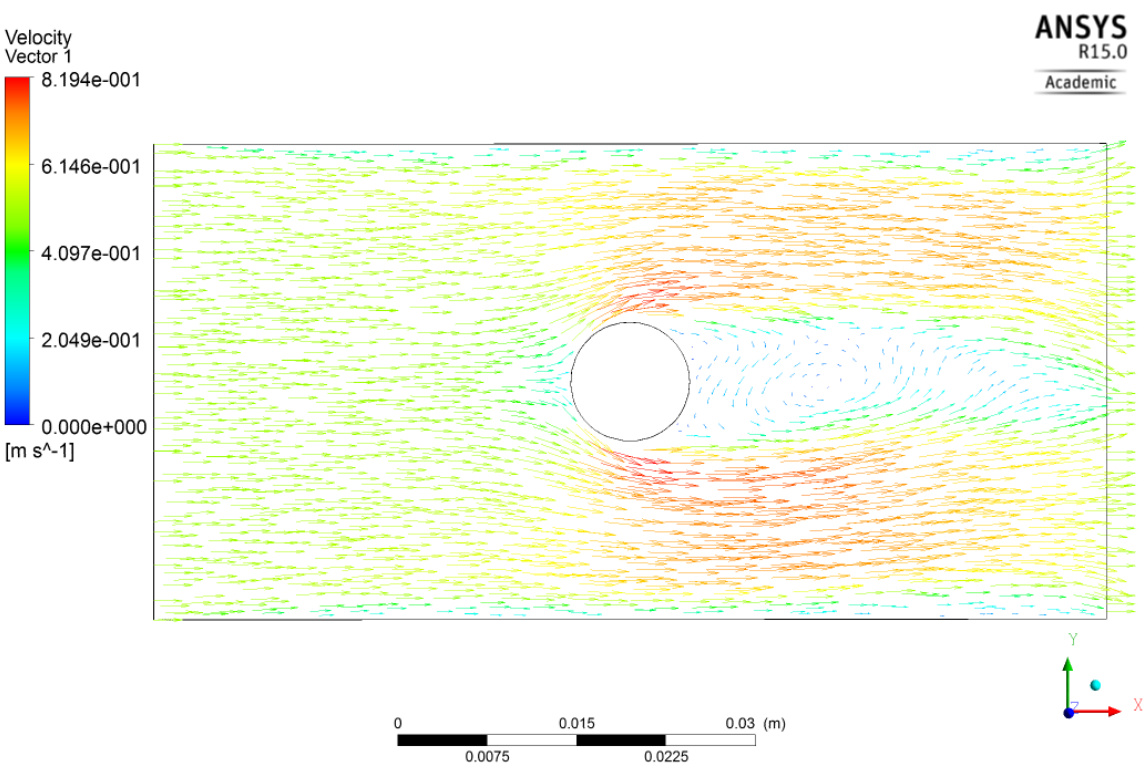


Fig. 6 Velocity vector distribution

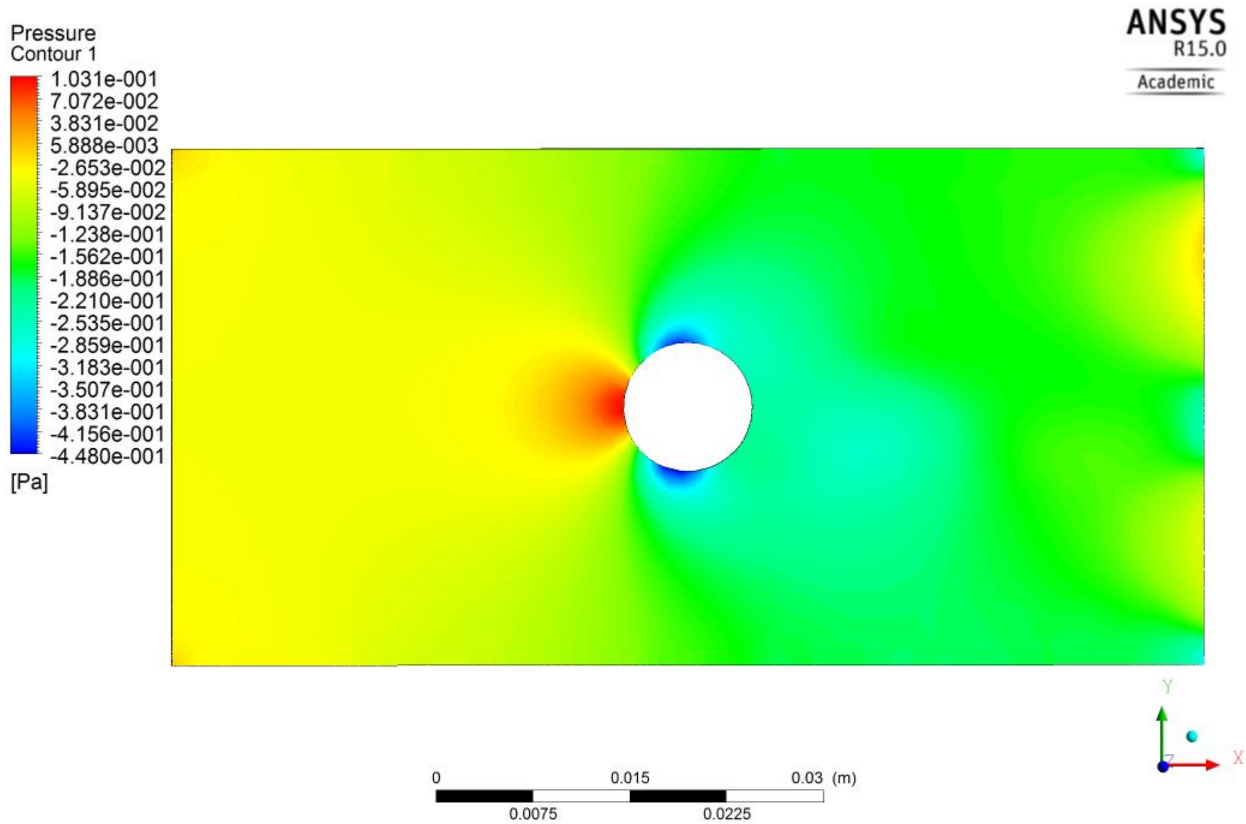


Fig. 7 Contour of the pressure distribution

The report generated from ANSYS is shown below.

1. File Report

Table 1. File Information for project_3_004

Case	project_3_004
File Path	S:\01-Course\5212\Project\computer_project\project_3_004.res
File Date	01 December 2015
File Time	07:34:41 PM
File Type	CFX5
File Version	15.0

2. Mesh Report

Table 2. Mesh Information for project_3_004

Domain	Nodes	Elements
Default Domain	7082	6721

3. Physics Report

Table 3. Domain Physics for project_3_004

Domain - Default Domain

Type	Fluid
Location	SURF
Materials	
Air at 25 C	
Fluid Definition	Material Library
Morphology	Continuous Fluid
Settings	
Buoyancy Model	Non Buoyant
Domain Motion	Stationary
Reference Pressure	1.0000e+00 [atm]
Heat Transfer Model	Isothermal
Fluid Temperature	2.5000e+01 [C]
Turbulence Model	Laminar

Table 4. Boundary Physics for project_3_004

Domain	**Boundaries**	
Default Domain	**Boundary - Inlet**	
	Type	INLET
	Location	INLET
	Settings	
	Flow Regime	Subsonic
	Mass And Momentum	Cartesian Velocity Components
	U	5.0000e-01 [m s^-1]
	V	0.0000e+00 [m s^-1]
	W	0.0000e+00 [m s^-1]
	Boundary - OUTLET	
	Type	OUTLET
	Location	OUTLET
	Settings	
	Flow Regime	Subsonic
	Mass And Momentum	Cartesian Velocity Components
	U	5.0000e-01 [m s^-1]
	V	0.0000e+00 [m s^-1]
	W	0.0000e+00 [m s^-1]
	Boundary - symmetry	

	Type	SYMMETRY
	Location	Primitive 2D C, Primitive 2D D
	Settings	
	Boundary - Default Domain Default	
	Type	WALL
	Location	CYLINDER
	Settings	
	Mass And Momentum	No Slip Wall
	Boundary - Wall	
	Type	WALL
	Location	WALL
	Settings	
	Mass And Momentum	No Slip Wall