<table>
<tr><td rowspan="6">Sl No</td><td colspan="7">CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
Department of Mechanical Engineering
1.3.3 – proofs</td><td></td></tr>
<tr><td colspan="7">Key Indicator -1.3 Curriculum Enrichment</td><td rowspan="5">Proof page no</td></tr>
<tr><td colspan="6">1.3.2 Number of value-added courses imparting transferable and life skills offered during the last five years</td><td></td></tr>
<tr><td colspan="7">1.3.3Avarage Percentage of students enrolled in the courses under 1.3.2 above</td></tr>
<tr><td colspan="7">AY 2023-24</td></tr>
<tr><td>Name of the value added courses (with30 or more contact hours) offered during AY 2023-24</td><td>Course Code, ifany</td><td>Year of offering</td><td>No. of times offered duringthe same year</td><td>Duration of the course</td><td>Number of students enrolled in the year</td><td>1.3.3 Number of students who completed the course during the year 2023-24</td></tr>
<tr><td>1</td><td>Computational Fluid Dynamics for Automobile and Aviation</td><td>CBIT/ME V02</td><td>Aug-Nov 2023</td><td>1</td><td>30 hours</td><td>28</td><td>25</td><td>2-55</td></tr>
</table>

Title of the value added course:

Computational Fluid Dynamics for Automobile and Aviation

Code: CBIT/MEV02

Duration: 30 hrs

(24th July to 11th Nov 2023)

Target participants: All UG students

Academic year: 2023 - 24

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COMMITTED TO RESEARCH, INNOVATION AND EDUCATION
45 years

Department of Mechanical Engineering

Circular

17/07/2023

Sub : Value Added courses of 2023-24 odd semester – Announcement

To enhance the knowledge in various areas beyond curriculum Value added course recommended. In this regard the interested students may register for the same on or before 23-07-2023. The course is scheduled from 24-07-2023 to 11-11-2023.

The list of courses :

1). MATLAB for Mechanical Engineers (CBIT/MEV01)
2). Computational Fluid Dynamics for Automobile and Aviation (CBIT/MEV02)

For further information contact courses coordinators.

Courses coordinators :

1). MATLAB for Mechanical Engineers (CBIT/MEV01) : K. Gurubrahmam, Assistant Professor, MED, 9491377882, gurubrahmam_mech@cbit.ac.in
2). Computational Fluid Dynamics for Automobile and Aviation (CBIT/MEV02) : Dr. Ch. Indira Priyadarsini, Assistant Professor, MED, 9440701652, Priyadarsini_mech@cbit.ac.in

Head
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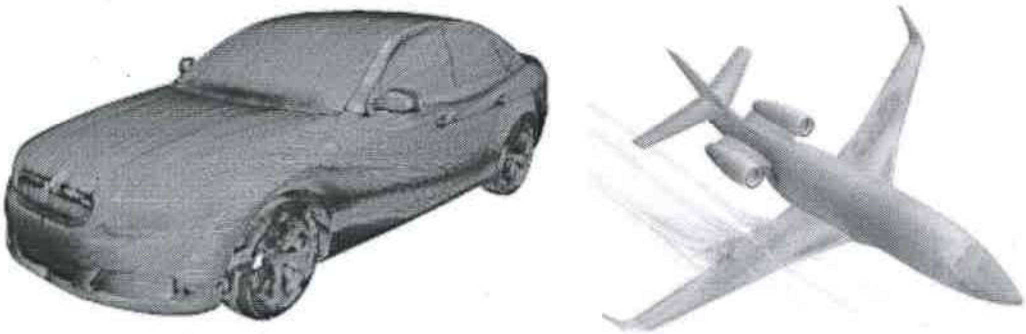
Department of Mechanical Engineering
Value Added Course
On

Computational Fluid Dynamics for Automobile and Aviation
AY-2023-24
24th July to 11th Nov 2023



Objective of the Course:

CFD gives insights into flow pattern that are difficult, expensive or impossible to study using traditional techniques (Experimental) techniques.

Introduction:

From the 1960s onwards the aerospace industry has integrated CFD techniques into the design, R&D and manufacture of aircraft and jet engines. More recently the methods have been applied to the design of internal combustion engines, combustion chambers of gas turbines and furnaces. Furthermore, motor vehicle manufacturers now routinely predict drag forces, under-bonnet air flows and the in-car environment with CFD. Increasingly CFD is becoming a vital component in the design of industrial products and processes.

Wind-tunnel testing is typically limited in the Reynolds number it can achieve, usually short of full scale. Very high temperatures associated with coupled heat transfer fluid flow problems are beyond the scope of many experimental facilities. This is particularly true of combustion problems where the changing chemical composition adds another level of complexity.

There are several unique advantages of CFD over experiment-based approaches to fluid systems design:

(i)substantial reduction of lead times and costs of new designs

(ii) ability to study systems where controlled experiments are difficult or impossible to perform (e.g. very large systems)

(iii)ability to study systems under hazardous conditions at and beyond their normal performance limits (e.g. safety studies and accident scenarios)

(iv) practically unlimited level of detail of results

(iii) provides more detailed and comprehensive information.

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(iv) is increasingly more cost-effective than wind-tunnel testing.

(v) produces a lower energy consumption.

Industry Growth

the investment costs of a CFD capability are not small, but the total expense is not normally as great as that of a high-quality experimental facility.

- The growth of the market can be attributed to rapid innovations in the aerospace and aeronautical and automobile industries.
- The global computational fluid dynamics market attained a value of USD 1.8 billion in 2020. The computational fluid dynamics (CFD) market share is expected to increase by USD 606.76 million from 2022 to 2025, and the market's growth momentum will accelerate at a CAGR of 12%.
- 37% of the market's growth will originate from Europe, Evolving opportunities with **Altair Engineering Inc.**, and **ANSYS Inc**. Market growth will be faster than the growth of the market in other regions.

Industries

Aero/Aviation/Automotive industries working with CFD:

Defence Research and Development Organisation (DRDO) Labs like, Advanced Systems Laboratory (ASL), Defence Research & Development Laboratory (DRDL), Advanced Numerical Research & Analysis Group (ANURAG), Gas Turbine Research Establishment (GTRE), Naval Science & Technological Laboratory (NSTL), Hindustan Aeronautics Limited(HAL), Aeronautical Development Agency (ADA), National Aerospace Limited (NAL), Indian Space Research Organisation (ISRO) etc., BHEL,

MNCs like SIEMENS, GE, Altair Engineering Inc., ANSYS Inc., Autodesk Inc., COMSOL AB, Convergent Science Inc., and Dassault Systemes SE, ESI Group, Hexagon AB, PTC Inc., and Siemens AG, Tech Mahindra, Wipro, HCL, GREAVES TECHNOLOGIES LIMITED , Caterpillar Inc, Intel, Infotech etc.,

Selection criteria:

- Students will be selected based on their CGPA in 2:1 ratio (10 students per course)
- Students has to give interview
- based on performance 10 students will be selected.

Modalities of the conduction of course:

- The course of 30 hours planned to conduct during college timings in Library period.
- Interested Students has to apply for the course.
- Students need to Submit all assignments and Present real time case study during the course as a project report.
- Certificate will be issued after completion of the course to the students with 80% attendance.

Outcome of the course: After completion of course students will be able to

1. Differentiate laminar and turbulent flow problems.

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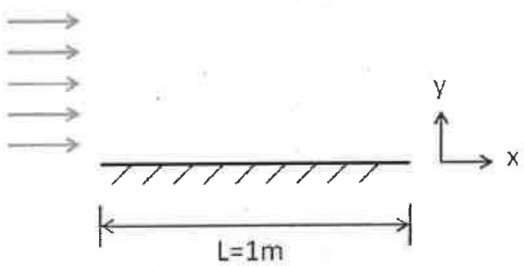
2. Analyze fluid flow distribution IC engine components.
3. Evaluate the importance and effect of angle of attack on aerofoil
4. Calculate the mach number, shock angle, pressure coefficient along the wedge and drag coefficient.
5. Present case studies related to aero and automobile industry

List of learning modules

Module No.	Topic	Duration (Hrs)
Module-1	Introduction; Governing equations used in CFD, Introduction to ANSYS Fluent, Study of the numerical solution to a Laminar & Turbulent flows	5
Module-2	Study of flow distribution in IC engine components like combustion chamber, exhaust manifold etc.	5
Module-3	Analyze effect of angle of attack on aerofoil NACA 0012 (Compressible Flow)	5
Module-4	Simulation of Supersonic Flow Over a Wedge to calculate the Mach Number, shock angle, pressure coefficient along the wedge and drag coefficient.	5
Module-5	Case studies based on Aerospace industrial problems.	5
Module-6	Case studies based on Automobile industrial problems.	5

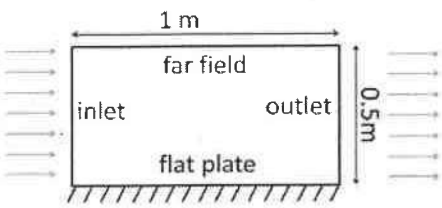
IC Engine wall Boundary



Consider a fluid flowing across a flat plate, as illustrated above. The plate length is 1 m. Hight is 0.5 m. The incoming fluid is flowing in the x-direction with a velocity of 1 m/s. The density of the fluid is 1 kg/m^3 and the viscosity is 1 x 10 ^(-4) kg/(m-s). Obtain the velocity and pressure distribution when the Reynolds number based on the plate length is 10,000.

Step 1: Pre-Analysis and Start-Up

Pre-Analysis



Start ANSYS FLUENT

- *Start> All Programs> Ansys 15 > Workbench*

The following figure shows the workbench window.

Step 2: Geometry

- **Fluid Flow(FLUENT) Project Selection**
- Left click (and hold) on *Fluid Flow (FLUENT)*, and drag the icon into the empty space in
- *Advance Geometry Options*, change the *Analysis Type* to

Launch Design Modeler

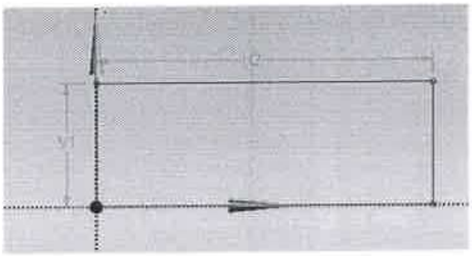
- In the *Project Schematic*, double click on *Geometry*

Creating a Sketch

- *XYPlane*. Under *Tree Outline*,
- select *XYPlane*, > *Sketching* > *Details View*. > *Sketching Toolboxes*.
- select *Rectangle*. In the *Graphics* window, create a rough rectangle by clicking once on the origin and then by clicking once somewhere in the positive XY plane.

Dimensions

- *Sketching Toolboxes* > select *Dimensions* tab, use the default dimensioning tools.



- Under the *Details View* > V1=0.5m and set H2=1m, as shown in the image below.

Surface Body Creation

- *(Click)Concept* > *Surface From Sketches*
- *SurfaceSK1*. Under *Details View*, select *Sketch1* as *Base Objects*. Finally, click *Generate* to generate the surface.

Step 3: Mesh

Launch Mesher

- *Workbench Project Page*, then *(Double Click) Mesh*.
- click on *Mesh*, then click on *Update* as shown in the image below.

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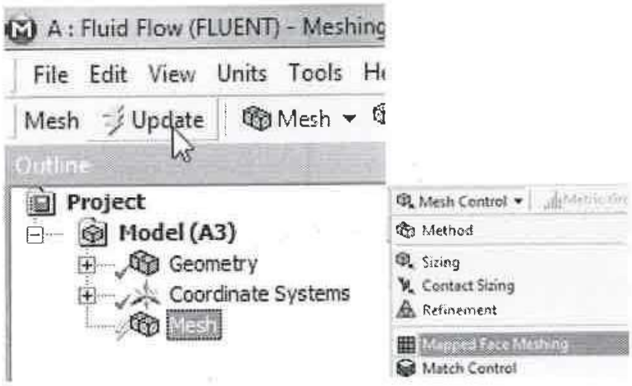


Mapped Face Meshing

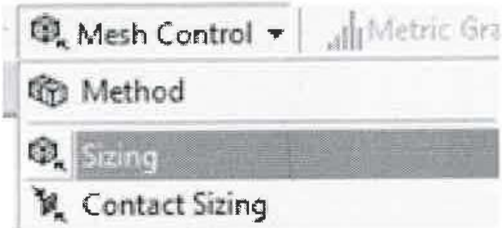
- ***Mesh Control > Mapped Face Meshing*** as can be seen below.

  (Click) Apply in the ***Details of Mapped Face Meshing***

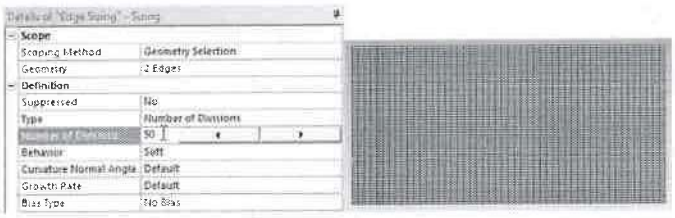
- Now, generate the mesh by clicking ***Update***.

Edge Sizing

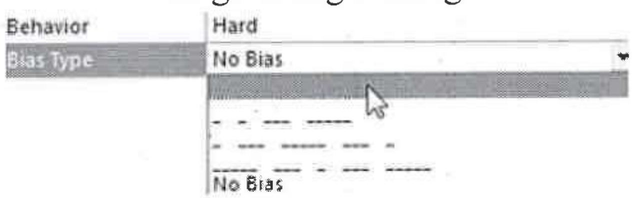
- ***(Click) Mesh Control > Sizing***



- ***(Click) Edge Selection Filter***, . Then hold down the "Control" button and then click the bottom and top edge of the rectangle. Both sides should highlight green. Next, hit ***Apply*** under the ***Details of Sizing*** table as shown below.
- Now, set ***Type*** to ***Number of Divisions*** as shown in the image below. Then, set ***Number of Divisions*** to 50 as shown below.



Edge Sizing Biasing



- ***Bias Factor*** to 70 as shown below. The ***Bias Factor*** is defined in this case to be the ratio of the longest division and the shortest division. That is, the last division will be seventy times longer than the length of the first division.

  (Click) Mesh Control > Sizing > Type to ***Number of Divisions*** and set ***Number of Divisions*** to 60. > ***Behavior*** to ***Hard*** and set ***Bias Type***

- set the ***Bias Factor*** to 70.> click ***Update*** to generate the new mesh.

Create Named Selections

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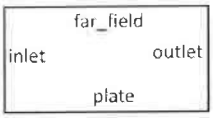
- *(Click) Edge Selection Filter*, . Then click on the left side of the rectangle and it should highlight green. Next, right click the left side of the rectangle and choose *Create Named Selection* as shown below.



- *Create Named Selection*. Enter "inlet" and click ***OK***, as shown below.
  Now, create named selections for the remaining three sides and name them

Save, Exit & Update

- *Workbench Project Page* and click the *Update Project* button, Update Project .

Step 4: Setup (Physics)

Launch Fluent

Double click on *Setup*

- *FLUENT Launcher* appears change the options to "Double Precision", and then click *OK*
  Define Solver Properties
- *Models > Energy-Off > Edit...*,
- *Models > Viscous - Laminar > Edit...*,
- By default, the Viscous Model options are set to **laminar**

Define Material Properties

- *(Click) Materials > Fluid > Create/Edit...*
- *Density* to 1kg/m^3 (constant)
- *Viscosity* to 1e-4 kg/(ms) (constant)
- Click *Change/Create*. Close the window.

Define Boundary Conditions

Inlet Boundary Condition

- *(Click) Boundary Conditions > inlet > Edit...*
- *Boundary Condition Type > velocity-inlet.*
- *Velocity Specification Method* to *Components*
- *X-Velocity (m/s)* to 1 m/s, as shown below.
- Then, click *OK* to close the *Velocity Inlet* menu.

Outlet Boundary Condition

- *(Click) Boundary Conditions > outlet > Edit*
- *Boundary Condition Type > pressure-outlet.*

Plate Boundary Condition

- *Boundary Condition Type >* to *wall*

Far-Field Boundary Condition

- *Boundary Condition Type > symmetry*,
- symmetry boundary conditions sets the velocities normal to the boundary equal to zero.

Step 5: Solution

- *Solution Methods > Momentum > Second Order Upwind*

Set Convergence Criteria

- *(Click) Monitors > Residuals > Edit...*,
- Lastly, click *OK* to close the *Residual Monitors* menu.

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Set Initial Guess

- *Solution Initialization > Compute from > inlet*
- click the *Initialize* button, Initialize . This completes the initialization process.

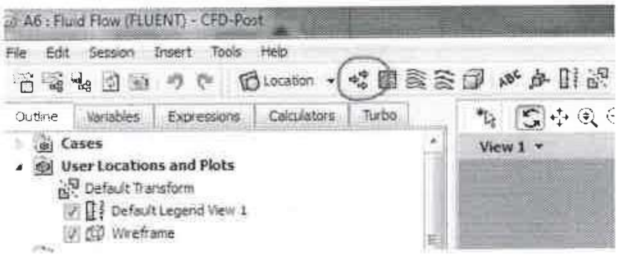
Iterate Until Convergence

- *Run Calculation > Number of Iterations* to 1000, as shown in the image below.

Step 6. Results

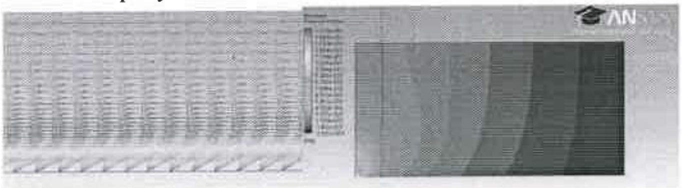
- Double click on Results from the Workbench Window to launch CFD-Post.

Velocity Vectors



- *Locations* to *symmetry 1*. Click on *Apply* to display the velocity vectors.

The velocity vectors will be displayed in the view window.



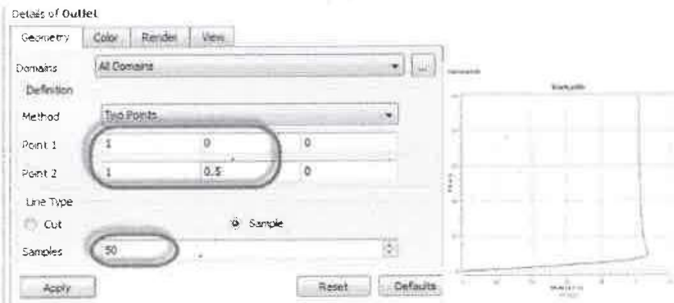
Pressure Contour

Insert > Contour. Name it Pressure contour.

Click on Apply to view the contour.

Outlet Velocity Profile

insert > location > line. Name it "Outlet"



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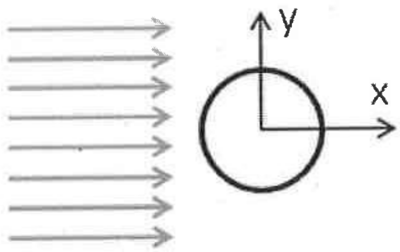
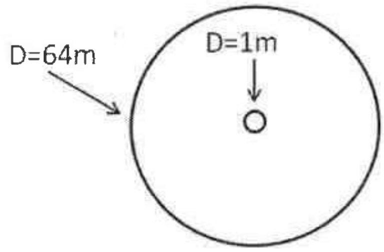
External Flow Problem

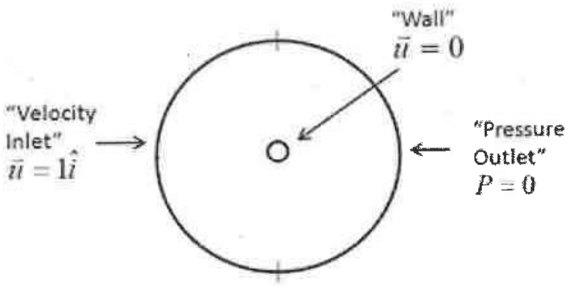


Consider the steady state case of a fluid flowing past a cylinder, as illustrated above. In order to simplify the computation, the diameter of the cylinder is set to 1 m, the x component of the velocity is set to 1 m/s and the density of the fluid is set to 1 kg/m^3. Thus, the dynamic viscosity must be set to 0.05 kg/m*s in order to obtain the desired Reynolds number.

Obtain the velocity and pressure distributions when the Reynolds number is chosen to be 20.

1. Pre-Analysis & Start-Up





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2. Geometry

- Drag ***Fluid Flow(FLUENT)*** into the ***Project Schematic*** window.

Analysis Type

- ***(Right Click) Geometry > Properties*** Set ***Analysis Type*** to ***2D***

Launch Design Modeler

- ***(Double Click) Geometry***

Create Inner Circle and Dimension

- Create a circle, centered around the origin in the xy plane. Set the diameter of the circle to 1m.

Inner Circle Surface Body Creation

- ***Concept > Surfaces From Sketches.***
- ***Base Object*** to Sketch 1 (located underneath ***XYPlane*** in the Tree). Click ***Generate***

Create New Sketch in the XY Plane

- Click on ***XYPlane*** in the ***Tree Outline*** and it should highlight blue. Then click on the ***New Sketch*** button, .

Create Outer Circle and Dimension

- Set the diameter of the circle to 64m.

Outer Circle Surface Body Creation

- ***Concept > Surfaces From Sketches.*** ***Base Object*** to Sketch 2 (located underneath ***XYPlane*** in the Tree). Then set ***Operation*** to ***Add Frozen***
  Then, click ***Generate***

Carry Out Boolean Operation: Subtraction

- **Create > Boolean.**

Operation to ***Subtract.***

- use the face selection filter, ,
- to apply the outer circle surface body as the ***Target Body.***
- use the face selection filter, , to apply the inner circle surface body as the ***Tool Body.*** Lastly, click ***Generate.***

Create a Bisecting Line

- Click on ***XYPlane***
- Then, click the new sketch button, .
- In the new sketch draw a line on the y axis that goes through both of the concentric circles. Make sure that it is coincident to the y axis.
- Then trim the line segments that lay inside of the inner circle and the line segments that lay outside of the outer circle.

Line Body Creation

- ***Concept > Lines From Sketches.***
  Set the ***Base Object*** to ***Sketch 3.*** (located underneath ***XYPlane*** in the Tree).
  Click ***Generate***

Projection

- *Tools > Projection*.
  Apply the two lines that you created to edge and apply the surface body to target.
- Click *Generate*.
- ***Save Project and Close Design Modeler***

3. Mesh

Launch Mesher

- *(Double Click) Mesh*

Mapped Face Meshing

- *(Right Click) Mesh > Insert > Mapped Face Meshing*
- Click *Update*.

Circumferential Edge Sizing

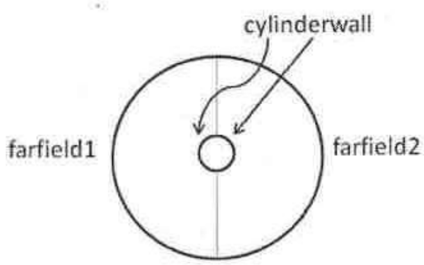
- *(Right Click) Mesh > Insert > Sizing*
- Set *Type* to *Number of Divisions*, set *Number of Divisions* to 96 and set *Behavior* to *Hard*.
- Click *Update* to generate the new mesh.

Radial Edge Sizing 1 (Top Half)

- *(Right Click) Mesh > Insert > Sizing*
- *Type* to *Number of Divisions*, set *Number of Divisions* to 96 and set *Behavior* to *Hard*.

Radial Edge Sizing 2 (Bottom Half)

Create Named Selections



4. Setup (Physics)

Launch Fluent

- *(Double Click) Setup* in the *Workbench Project Page*.
- Select *Double Precision*.

Specify Material Properties

- *Problem Setup > Materials > Fluid > Create/Edit....*
- *Density* to 1 kg/m^3 and set *Viscosity* to 0.05 kg/m*s. Click *Change/Create* then click *Close*.

Boundary Conditions

FarField1

- *Problem Setup > Boundary Conditions > farfield1. velocity-inlet*. Click *Edit....*

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- Set *Velocity Specification Method* to *Components*, set *X-Velocity* to 1 m/s, and set *Y-Velocity* to 0 m/s.

FarField2

- *Problem Setup > Boundary Conditions > farfield2..*
  Set *Type* to *pressure-outlet.*

Cylinder Wall

- *Problem Setup > Boundary Conditions > cylinderwall.*
  Set *Type* to *wall.*

Reference Values

- *Problem Setup > Reference Values.*
  Set the *Density* to 1 kg/m^3. The other default values will work for the purposes of this simulation.

Save Project

5. Solution

Second Order Upwind Momentum Scheme

- *Solution > Solution Methods > Spatial Discretization.*
  Set *Momentum* to *Second Order Upwind*

Convergence Criterion

- *Solution > Monitors > Residuals > Edit....*
  Set the *Absolute Criteria* for , *x-velocity* and *y-velocity* all to 1e-6. Click *ok*
- *Solution > Monitors > Drag > Edit....*
  Then check *Print to Console* and *Plot*. Next, click *cylinderwall*, which is located under *Wall Zones*. Lastly, click *ok*

Initial Guess

- *Solution > Solution Initialization.*
- *Compute From* to *farfield1.*
- click *Initialize.*

Iterate Until Convergence

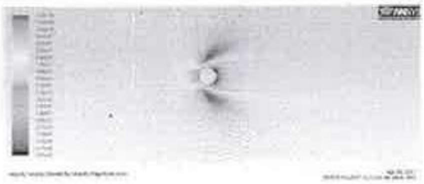
- *Solution > Run Calculation.*

- *Number of Iterations* to 2000. Then, click *Calculate*. Save Project

6. Results

Velocity Vectors

- *Results > Graphics and Animations > Vectors > Set Up...*
  Then click *Display*. The *Scale* was set to 2 in the plot below.



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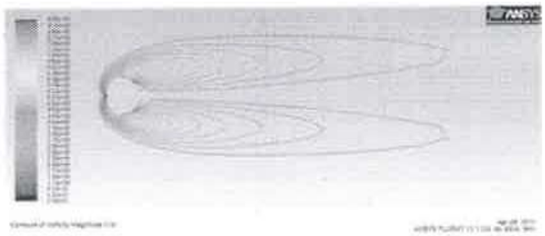
Stream Lines

- *Results > Graphics and Animations > Contours > Set Up...*
  Set *Contours of* to *Velocity..* and set the box below to *Stream Function.*

Vorticity

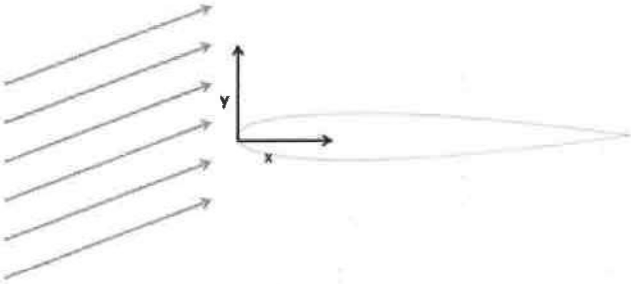
- ***Results > Graphics and Animations > Contours > Set Up...*** Set ***Contours of*** to ***Velocity..***
- set the box below to ***Vorticity Magnitude***.
- Then click ***Display***. The plot below was created by by setting ***levels*** to 60, deselecting ***Auto Range***, setting ***Min (1/s)*** to 0.25 and setting ***Max (1/s)*** to 9.



Airfoil

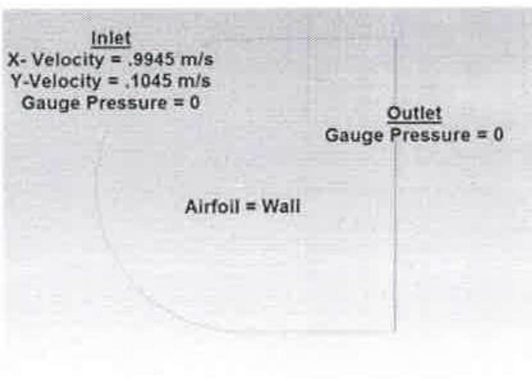
Problem Specification

In this tutorial, we will show you how to simulate a NACA 0012 Airfoil at a 6 degree angle of attack placed in a wind tunnel. Using FLUENT, we will create a simulation of this experiment. Afterwards, we will compare values from the simulation and data collected from experiment.



Pre-Analysis & Start-Up

Boundary Conditions



1. Geometry

Download the Airfoil Coordinates

Launch Design Modeler

Airfoil

- **Concept > 3D Curve**. In the *Details View* window,
- click *Coordinates File* and select the ellipsis to browse to a file.
- click Generate to create the curve. Click to get a better look at the curve.

Concepts > Surfaces from Edges.

- Click anywhere on the curve you just created, and
- select *Edges* > *Apply* in the *Details View* Window. Click Generate to create the surface.

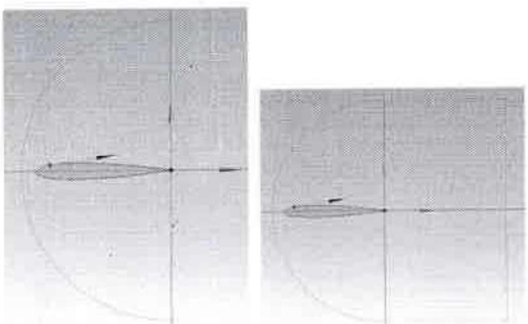
Create C-Mesh Domain

- Click to create a new coordinate system. In the *Details View* window,
- select *Type* > *From Coordinates*. For ***FD11, Point X***, enter 1.

Click Generate to generate the new coordinate system.

- In the *Tree Outline* Window, select the new coordinate system you created (defaulted to *Plane 4*), then click to create a new sketch.
- click the **Sketching** tab to bring up the sketching window.
- Click Arc by Center.
- The first click selects the center of the arc, and the next two clicks determine the end points of the arc. We want the center of the arc to be at the tail of the airfoil. Click on the origin of the sketch, making sure the P symbol is showing

For the end points of the arc, first select a point on the vertical axis above the origin (a C symbol will show), then select a point on the vertical axis below the origin. You should end up with the following:



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To create the right side of the C-Mesh donain,

- click Rectangle by 3 Points.
- Click the following points to create the rectangle in this order - where the arc meets the positive vertical axis, where the arc meets the negative vertical axis, then anywhere in the right half plane. The final result should look like this:above fig.

Now, we need to get rid of necessary lines created by the rectangle.

- Select *Modify* in the *Sketching Toolboxes* window,
- then select Trim .
- Click the lines of the rectangle the are collinear with the positive and negative vertical axises. Now,
- select the ***Dimensions*** toolbox to dimension the C-Mesh domain.
- Click Radius , followed by the arc to dimension the arc. Assign the arc a value of `12.5`. Next,
- select Horizontal .
- Click the vertical axis and the vertical portion of the rectangle in the right half plane. Also assign the horizontal dimension a value of `12.5`.
- **Concept > Surface From Sketches.**
- Click anywehere on the sketch, and select *Base Objects > Apply* in the *Details View* Window. Also,
- select*Operation > Add Frozen*.
- click Generate .

The final step of creating the C-Mesh is creating a surface between the boundary and the airfoil.

- **Create > Boolean.**
- *Operation > Subtract.*
- *Target Bodies > Not selected,*
- select the large C-Mesh domain surface, then click *Apply*.
- Repeat the same process to select the airfoil as the *Tool Body*. When you have selected the bodies, click Generate

Create Quadrants

- break up the new surface into 4 quadrants;
- select *Plane 4* in the *Tree Outline* Window, and click .
- Open the sketching menu, and select Line . Draw a line on the vertical axis that intersects the entire C mesh. Trim away the lines that are beyond the C-Mesh, and you should be left with this:

- **Concepts > Lines from Sketchs.** > click *Base Objects > Apply*, followed by Generate . Now that you have created a vertical line, create a new sketch and repeat the process for a horizontal line that is collinear to horizontal axis and bisects the geometry.
- *Tools > Projection*. Select *Edges* press **Ctrl** and select on the vertical line we drew (you'll have to select both parts of it), then press *Apply*. Next, select *Target* and select the C-Mesh surface, then click *Apply*.
- Once you click Generate , you'll notice that the geometry is now composed of two surfaces split by the line .Repeat this process to create 2 more projections: one projection the line left of the origin onto the left surface, and one projecting the right line on the right surface. When you're finished, the geometry should be split into 4 parts.

2. Mesh

Mapped Face Meshing

- **Mesh Control** > **Mapped Face Meshing**. Making sure the face selection filter is selected ,
- *Geometry* > *Apply*. Next, select

Edge Sizing

- **Mesh Control** > **Sizing**. Next, click the edge selection filter .
- Select the following 4 edges buy holding Ctrl and using the left mouse button:

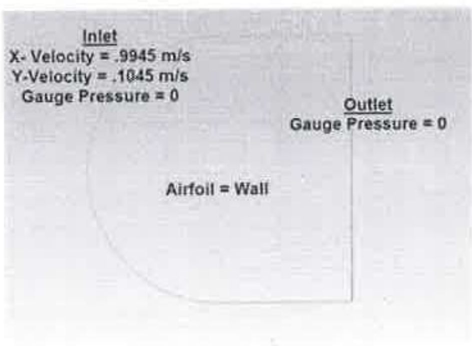
- *Geometry* > *Apply*. Next, select *Type* > *Number of Divisions*. Change the *Number of Divisions* to `50`.
- Select *Behavior* > *Hard*. We also want the mesh to have a bias, so select the first bias type: *Bais* > ----- — - -, and give the edge sizing a *Bias Factor* of `150`. The Edge sizing should now look like this:

- Create a new edge sizing with the same parameters, but choose the 4 remaining straight edges (see figure below). The number of divisions will still be 50, but now will be selecting a different biasing type by selecting the second Bias option: *Bias* > - - — -----. Again, set the *Bias Factor* to `150`

- third edge sizing, and select the rounded edges as the geometry> *Type* > *Number of Divisions*, > *Number of Divisions* to `100`.>*Behavior* > *Hard*. This time, we will not bias the edges.

- **Mesh** > **Generate** to generate the mesh. It should look like this.

Named Selections



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3. Setup

Launch the Solver

Select the Solver

Click *OK* to launch Fluent.

- *Problem Setup > General*. Under *Solver*, select *Density-Based*.

Models and Materials

- *Problem Setup > Models > Viscous-Laminar*. Then press *Edit..*
- *Inviscid* and press**OK**.
- click *Problem Setup > Materials > (double click) Air*.
- Under *Properties*, ensure that density is set to *Constant* and enter `1 kg/m^3` as the density. Click *Change/Create* to set the density.

Boundary Conditions

Inlet

- *Problem Setup > Boundary Conditions*.
- *Velocity Specification Method > Components*.
- Specify *X-Velocity* as `0.9945 m/s` and *Y-Velocity* as `0.1045 m/s`. press *OK*

Outlet

- Select *Outlet*
- *pressure-outlet*: if it didn't, select it. Click *Edit*,
- *Gauge Pressure* is defaulted to `0`.

Airfoil

In the *Boundary Conditions* window, look under *Zones* and

- select *airfoil*. Select *Type > Wall* if it hasn't been defaulted.

Reference Values

- *Problem Setup > Reference Values*.>*Compute From > Inlet*.

Solution

Methods

- *Solution > Solution Methods> Second Order Upwind*.

Monitors

- *Solution > Monitors*. In **Monitors**. Select *Residuals - Print,Plot* and press *Edit*. In the *Residual Monitors* Window, we want to change all of the *Absolute Criteria* to `1e-6`.

Initial Guess

- *Solution > Solution Initialization*.> *Compute From > Inlet*. >clicking *Initialize*.

Solve

- *Solution > Run Calculation*. Change *Number of Iterations* to `3000`, >click *Calculate*.

<u>6.Results</u>

Velocity

- *Results > Graphics and Animations*.> select *Vectors*and click *Set Up...*.
- *Vectors of > Velocity*, *Color by > Velocity*, and set the second box as *Velocity Magnitude*. To see the velocity vectors, press *Display*.

Pressure Contours

- ***Results*** > ***Graphics*** ***and*** ***Animations*** > select ***Contours***. Click ***Set Up...***
- selected are ***Pressure...*** and ***Static Pressure***.> press ***Display***

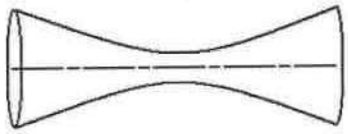
Streamlines

- ***Contours Of*** box to ***Velocity***,
- ***Stream Function***. Change ***Levels*** to `100`. Also, uncheck the box marked ***Auto Range***, and set ***Min(kg/s)*** to `13.11`, and ***Max(kg/s)*** to `14.16`

Turbulent Flow through a Nozzle

Problem Statement:

Consider a convergent-divergent (CD) nozzle with circular cross section. Let that area vary as a function of the length of the nozzle. Since the area is circular, axisymmetric flow can be assumed and only the upper portion will be modeled for simplification purposes.



- In Main Menu—Concept select 3d Curve.
- In Details View next to Definition specify From Coordinates File.
- Underneath specify the location of the .txt coordinates file.
- Click Generate.
- Open an Excel file and following the format outlined and using the equation expressing the radius of the nozzle (y-axis) as a function of the distance (x-axis)—Eq.3,
- create an Excel worksheet and save it as a .txt file. The final result should look like this:
- For a step size 0.01 is used for the nozzle's distance range of -0.5 to 0.5 meters.
- It is a 2d problem hence the z-dir. coordinates are kept at 0.
- As a result 101 coordinate points are specified and it should be noted that the more points that are entered, the smoother the curve will be.

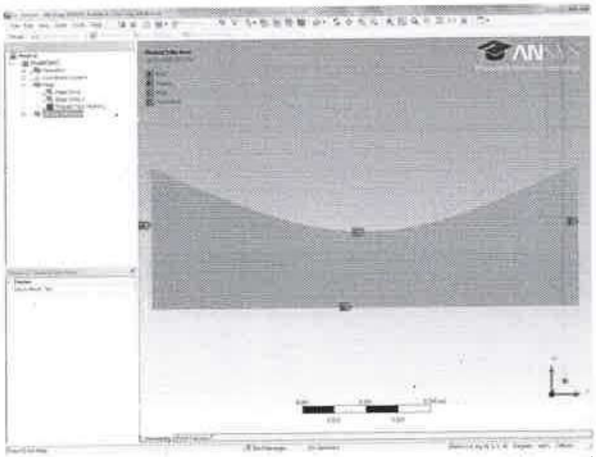
So far the wall and centerline surfaces have been created—we have 2 edges.

- Next the inlet and outlet ones will be modeled.
- The left edge will represent the inlet and to create the line we need the -0.5, 0, 0 point on the x-axis alongside its corresponding point on the curve.
- Same applies for the right edge which is to represent the nozzle's outlet. In order to do that we will plot the individual points of the curve and manually select the needed points.
- Select Point and specify the .txt coordinate file; click generate.
- The final step before obtaining the geometry for the nozzle is to create the surface from the existing edge.

Mesh: create mesh

The four boundary zones must be specified.

- Select the edge cube and after selecting an edge
- right click it and choose Create Named Selection.
- Name the left edge "Inlet", the right one "Outlet", the top edge "Wall" and the bottom edge "Centerline".



Consider the following values for the specific flow problem:

$L_{nozzle} = 10.0\ m;\ D_{exit} = 1.5\ m$;

$$L_{throat} = 5.0\ m;\ D_{throat} = 1.0\ m$$

$$T_{inlet} = 293.0\ K$$

$$V_{inlet} = 0.24\ Ma$$

$$\frac{A_{exit}}{A_{throat}} = 1.5;\ \frac{A_{inlet}}{A_{throat}} = 2.5;\ \frac{P_{outlet}}{P_{inlet}} = 0.75$$

The velocity is given as 0.24 Ma and the specific value must obey only the rule that the inlet velocity is subsonic. The velocity can be converted to meters per second and it is important to do the calculation since that value will be entered in ANSYS Fluent in order to set both the reference values and to initialize the problem.

$$Ma = \frac{v}{c}\ and\ c = \sqrt{R * T * k} \quad (2)$$

Where: c is the speed of sound which varies with temperature and fluid type. For example the speed of sound in water is much higher than in air.

The stagnation temperature must be calculated as well as it will be entered in Fluent. Equation 3is to be used which stems from the assumed Quasi 1D approach. Note T is the inlet temperature and T_0 is the stagnation temperature which is the temperature at a point of zero fluid velocity.

Equation 2 is used to compute **the total gauge pressure at the inlet, P.** The equation stems from the assumed Quasi 1D approach and it is important to calculate the pressure since they are to be entered in Fluent. The stagnation pressure is the pressure at a point of zero fluid velocity and kinetic energy has been converted to pressure energy.

$$\frac{P}{P_0} = \left(\frac{1}{1+\frac{k-1}{2}*Ma^2}\right)^{k/(k-1)} \quad (2)$$

$$\therefore \frac{P}{P_0} = \left(\frac{1}{1+\frac{1.401-1}{2}*.24}\right)^{1.401/(1.401-1)} = 1.041$$

However, the pressure of the outlet is 1 atm or 101,325 Pa since the operating pressure is 0 because only the gauge pressures are of interest--$p_{gauge} - p_{operating} = 0$. Recall $\frac{P_{outlet}}{P_{inlet}} = 0.75$.

$$\therefore P_0 = \frac{P_{outlet}}{0.75} = \frac{101{,}325}{0.75}\ \text{Pa} = 135{,}100\ \text{Pa}$$

$$\therefore P = P_0 * 1.041 = 140{,}639\ Pa$$

Problem Setup—Models:

Under Models

- Double click Energy and put a checkmark thus turning it on.
- Press Ok. It is important to consider the energy equation since we are dealing with compressible flow and we are interested in temperature effects.
- The energy equation now will be calculated alongside the continuity and momentum ones.

Since the Quasi-One dimensional flow approach is assumed for analysis and validation in this tutorial the flow is assumed to be inviscid. Under Models, double click Viscous and select Inviscid.

Problem Setup—Materials:

Underneath Materials, under Fluid double

- Click Air. Under Properties

Next to Density specify Ideal Gas. Since in compressible flow the density is not constant, the value can be seen to be blank. Air is analyzed as an ideal gas. Press Change/Create

Problem Setup—Boundary Conditions:

- Since the fluid flow is assumed to be air as an ideal gas the pressure must be expressed as an absolute pressure.
- Click on Operating Conditions and it can be seen that by default the Operating Pressure (gauge pressure) is set at 101,325 Pa or 1 atm.

Make it equal to 0 and press OK

Change the **Axis zone to type Axis** (the problem has already been specified as Axisymmetric in the Problem Setup—General).

- Verify that the **wall zone is of type wall, the inlet zone is of type pressure inlet**, the **outlet zone if of type pressure outlet** and **the interior zone is of type interior**.

Double click on the outlet zone and enter 101 325 Pa as the outlet gauge pressure

- In the Thermal tab specify the backflow total temperature as 296.375 K. Refer to the problem statement for the calculations performed to obtain those values. Press OK.

Problem Setup—Boundary Conditions:

- Double click on the inlet zone.
- Enter 140,639 Pa as the Total Gauge Pressure, P.
- Specify 135,100 Pa as the Initial Gauge Pressure, P_0 (stagnation pressure).
- Refer to the problem statement for the manner in which the two values were obtained
- Set the total temperature in the thermal tab to equal to 296.375 K (ref. to problem statement for calculation).
- **Problem Setup—Reference Values:**
- Set the reference values to be computed from the inlet. Verify the values for temperature and velocity among others make sense. It can be seen there are small variation for the temperature (it was chosen as 293K at the inlet) and the velocity (it was computed as 82.362 m/s at the inlet, ref. to Problem Statement Section).

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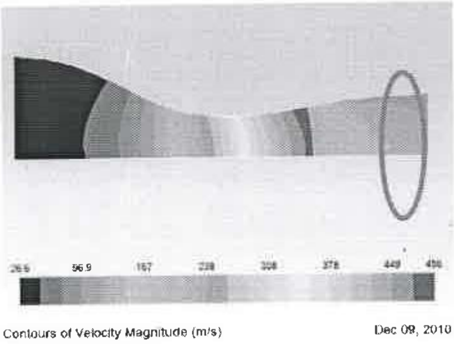
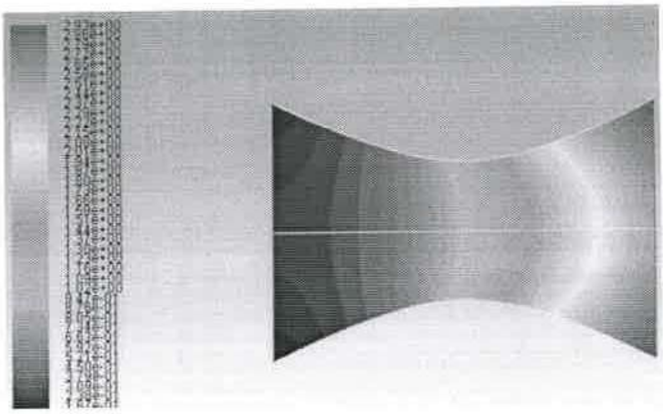
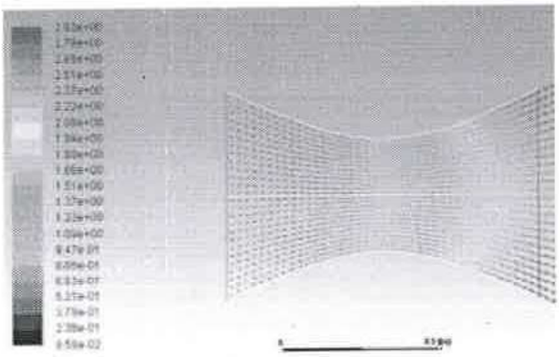


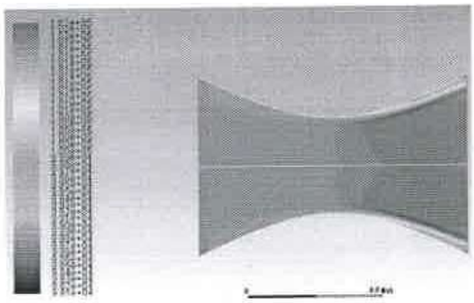


MACH NUMBER

- The shock inside the nozzle can be clearly seen (circled region). Vast velocity difference is exhibited on each end of the shock.



VELOCITY IN NOZZLE



PRESSURE

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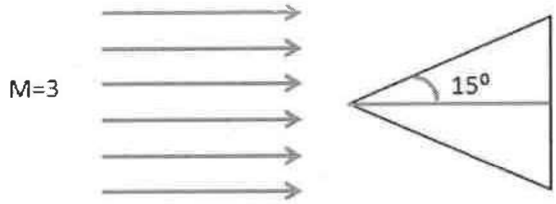
Wedge with supersonic stream

Problem Specification A uniform supersonic stream encounters a wedge with a half-angle of 15 degrees as shown in the figure below. The stream is at the following conditions:



Mach Number $M_1 = 3$

Static Pressure $p_1 = 1\ atm$

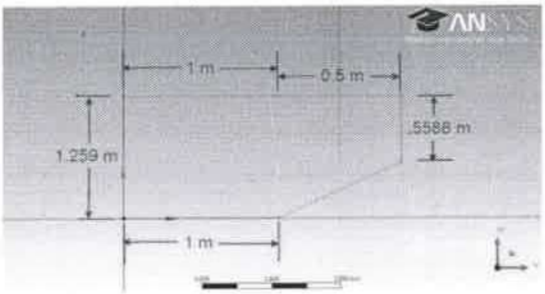
Static Temperature $T_1 = 300\ k$

Using Ansys Fluent, calculate the Mach Number, static and total pressure behind the oblique shock that will be formed. Also, calculate the shock angle, pressure coefficient along the wedge and drag coefficient. Compare the Fluent results with the corresponding analytical results.
In the hand calculations we will be applying the conservation of energy, mass and momentum equations for a 1D inviscid compressible flow. This differs from the way that Fluent solves the problem, as Fluent instead uses the 2D inviscid compressible flow equations.

$$\frac{\partial e}{\partial t} + \mathbf{u} \cdot \nabla e + \frac{p}{\rho}\nabla \cdot \mathbf{u} = 0 \qquad \frac{\partial \rho}{\partial t} + \mathbf{u} \cdot \nabla \rho + \rho \nabla \cdot \mathbf{u} = 0$$

$$\frac{\partial \mathbf{u}}{\partial t} + \mathbf{u} \cdot \nabla \mathbf{u} = -\frac{\nabla p}{\rho}$$

1. Geometry
Create Design Modeler



2. Mesh
Mesh Control > Face Meshing
click ***Geometry > Apply***
Body Sizing
Mesh Control > Sizing. Next, select the body selection filter in the menu bar:

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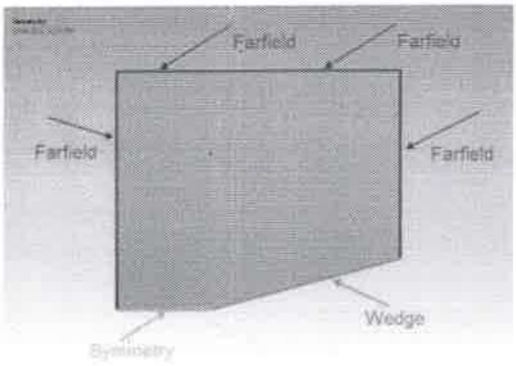
In the *Details* window, select ***Geometry > Apply***. ***Element Size > Default*** and change the value to ***0.05 m***.

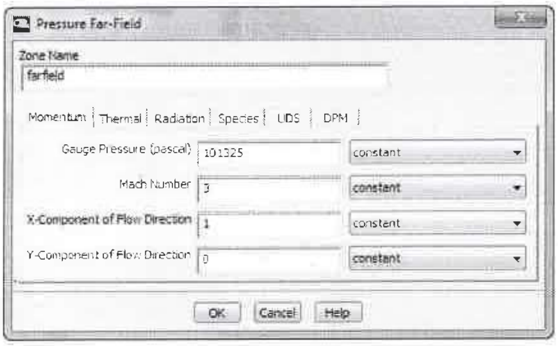
Mesh > Generate Mesh



3. Setup
Launch the Solver-Select the Solver-Click OK to launch Fluent.Energy-On-invicid,
Problem Setup > General. Under Solver, select density based

Models and Materials
Density to Ideal Gas, the default values for Cp (1006.43), and the Molecular Weight (28.966) density. Click Change/Create to set the density.

Boundary Conditions
Select farfield. Use the drop-down menu to change the Type to pressure-far-field. Change the Gauge Pressure (Pascal) to 101325, and Mach Number to 3.Also, select the Thermal tab, and ensure that the temperature correctly defaulted to 300 K. When you are finished, press OK.



Wedge In the Boundary Conditions window, select wedge. change the Type to wall.
Symmetry In the Boundary Conditions window, select symmetry.
Operating Conditions In the Boundary Conditions window, select the Operating Conditions button. Change the Gauge Pressure to 0. Then press OK
in materials to *Ideal Gas*, Fluent calculates the density using the absolute pressure. However, the pressure we specify is the gauge pressure, not the absolute pressure. Fluent will use the absolute pressure to compute the density, therefore if we do not set the operating pressure to 0 our density will be incorrect for the flow field.
Reference Values In the Outline window, select Reference Values. Change the Compute From

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parameter to farfield.

Solution

Solution Methods to open the Solution Methods window. Under Spatial Discretization, ensure that the option under Flow Second Order Upwind is selected. Solution Controls In the Outline window, select Solution Controls to open the Solution Controls window. Ensure that the Courant Number is set to 5.0.

Solution Initialization

Compute From parameter to farfield.

if your solution is having convergence issues, try to use Third Order MUSCL under Solution Methods > Spatial Discretization.

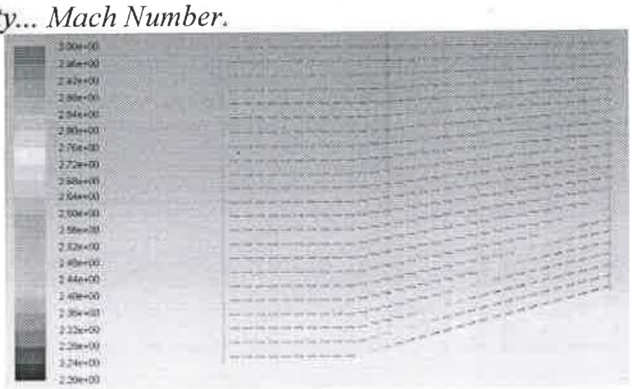
Third Order MUSCL helps to converge the solution, especially if you are seeing many oscillations between a few values in your residuals.

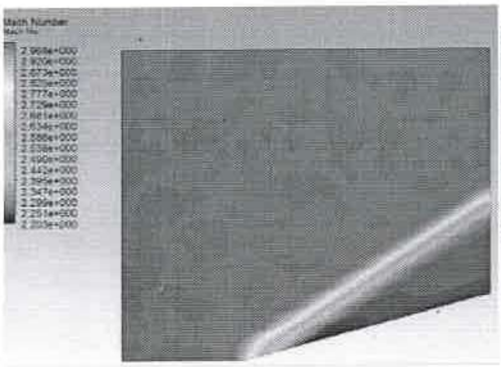
6.Results

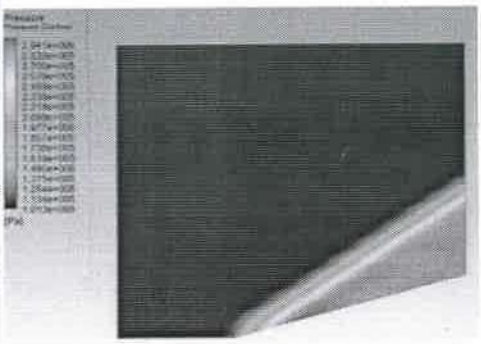
Velocity Vectors

In the *Outline* window, under *Results* select *Colors and Animations*. In the *Colors and Animations* window, under *Graphics*, select *Vectors*. Then press *Set Up...*.

In the *Vectors* window that opens, change the *Scale* of the arrows to *0.25*, and change the *Color by* parameter to *Velocity... Mach Number.*







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Timestamp	Email	Roll No	Name of the Student	Phone umber	CGPA	Why do you want to attend this course:
2023/09/08 9:37:34 AM GMT+5:30	msrihitha0305@gmail.com	160120736305	Srihitha Malisetty	8500706695	8.05	I want to explore the ways where my knowledge in mechanical can excel.
2023/09/08 9:44:06 AM GMT+5:30	bharathpol2002@gmail.com	160120736015	Bharath Pol	9640496653	8.68	Currently the design lead at SAE CBIT, very handy with solidworks and fusion 360 but want to learn CFD software to perform aero on nose cones of vehicle to add on extra points while applying for core jobs.
2023/09/08 9:45:57 AM GMT+5:30	mrfurqaan431@gmail.com	160120736029	Mohammed Furqaan Jamal	7396562440	7.47	Because I wanna make my career in CFD
2023/09/08 9:46:46 AM GMT+5:30	mukundvishwanathacademic@gmail.com	160120736031	Mukund Balraj Vishwanath	6302135474	7.83	I am planning to do my MS in Robotics, and CFD will be an important subject for me in robotics design. I want to learn this to ensure im ready for advanced coursework in my post grad.
2023/09/08 10:10:27 AM GMT+5:30	ayushi2024.chaturvedi@gmail.com	160120736001	Ayushi Chaturvedi	6303601280	8.12	I am an aerospace enthusiast and having practical knowledge on CFD is essential for my career ahead. Since the opportunity has been presented to us within our own institution, I would want to leverage that to enhance my skillset.
2023/09/08 10:22:46 AM GMT+5:30	sureshbanoth464@gmail.com	160120736106	BANOTH SURESH	9392485831	8.9	In last semester I have choosen cfd elective,so this course may help me in explore more.
2023/09/08 10:25:02 AM GMT+5:30	srichandanareddy1328@gmail.com	160120736072	SriChandana	6302682035	8.58	I do have prior knowledge in cfd still want to explore more .
2023/09/08 10:28:37 AM GMT+5:30	pranavsagar0304@gmail.com	160120736086	Pranav	9963727809	7.5	Aspiring to become an entrepreneur. Having a knowledge in various industries would add value to my skill set.

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2023/09/08 10:29:41 AM GMT+5:30	ugs202244_mech.afreen@cbit.org.in	160120736061	Afreen begum	8310594448	8.44	To know in detail about CFD techniques involved in aerospace and also presenting the case studies will give more knowledge about aerospace industrial problems.
2023/09/08 10:33:31 AM GMT+5:30	vvenu8372@gmail.com	160120736110	Putta venu	6281837084	8.5	I have only basics of cfd and I want improve this skill and gain experience by this course . Also Cfd calculations help engineers in diverse fieldsâ€"from environmental engineering to aerospaceâ€"design better products faster. Also this course will added to resume which increase my chances hiring in core placemnts.
2023/09/08 10:51:52 AM GMT+5:30	thumugantikarthik@gmail.com	160120736082	Thumuganti Karthik	9515970526	9.27	Actually iam pretty much interested in the field of automobiles and analysis stuff, egarly waiting for the opportunity for gaining skills and knowledge in that fields, hope this course would be helpful for me in knowing the indepth concepts
2023/09/08 10:52:28 AM GMT+5:30	vishnuallagadda026@gmail.com	160120736089	ALLAGADDA NAGAVISHNU	8297345288	7.97	I want to improve my knowledge on CFD for Automobile and Aviation as it helps in my further studies
2023/09/08 11:08:02 AM GMT+5:30	chbsankar2003@gmail.com	160120736078	Bhavani Sankar Chodavarapu	8125012979	8.78	I am veru much intrested in Aviation and stuff
2023/09/08 11:12:17 AM GMT+5:30	ugs202215_mech.jashwanth@cbit.org.in	160120736080	G Jashwanth	9493803616	8.78	I'm interested in cfd related courses and I see there is a lot of scope in this field. The challenging problems solved using cfd really intrigues me.
2023/09/08 11:12:48 AM GMT+5:30	Vadityas2532@gmail.com	160130736074	Aditya Varupula	9384712345	6.98	I have a keen interest in pursuing aeronautical engineering and this course could be of great use towards it.

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2023/09/08 11:24:40 AM GMT+5:30	praneethram2003@gmail.com	160120736091	KUMMARA PRANEETH RAM	8179378719	8.42	CFD was my elective
2023/09/08 12:01:36 PM GMT+5:30	rishab2erramilli@gmail.com	160120736093	Rishab Erramilli	7032826802	8.71	I have always had an interest towards CFD simulations and that led to me taking up CFD in 6th semester. Since it was highly theoretical with no practical application, it felt quite difficult to understand. With this course, I'll be able to simulate fluid flows and understand the governing equations even better. This course will also add some value to me as an engineer so that I can contribute to the industry in a more efficient manner.
2023/09/08 2:36:02 PM GMT+5:30	ugs202215_mech.jashwanth@cbit.org.in	160120736080	G Jashwanth	9493803616	8.78	I'm interested in cfd. The challenging problems in this are really intrigues me. I see there is a lot of scope in the field of cfd and I want to continue my career in the same field.
2023/09/08 2:49:02 PM GMT+5:30	ashwinichepuri453@gmail.com	160120736304	CHEPURI ASHWINI	6304190216	7.9	I want to add analytical skills to my personality
2023/09/08 10:32:43 PM GMT+5:30	vishi08536@gmail.com	160120736103	Shashi Kiran Mankala	8978030952	8.65	I want to attend this course to gain practical skills in CFD.
2023/09/08 10:43:01 PM GMT+5:30	chamanthularohith7@gmail.com	160120736303	ROHITH CHAMANTHULA	8464996570	9.11	I want to enroll in this course to put into practice the theoretical knowledge I acquired during my elective course(cfd) in the third year and gain practical skills.
2023/09/09 1:15:07 PM GMT+5:30	sridhananivasrgp@gmail.com	160120736020	Marikukala Dhana Nivas	9705685434	8.4	I want to learn how fluid can be analysed
2023/09/09 1:46:29 PM GMT+5:30	sai.titu17@gmail.com	160120736100	T. Sai Samanvith	6303761841	8.78	Interested
2023/09/09 6:18:13 PM GMT+5:30	chandrakanthsingh47@gmail.com	160120736017	G CHANDRAKANTH SINGH	8688236520	7.27	It has a huge scope in future
2023/09/09 11:24:29 PM GMT+5:30	sai.tiru17@gmail.com	160120736100	T. Sai Samanvith	6303761841	8.78	Interested

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Department of Mechanical Engineering
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2023/09/14 7:34:40 PM GMT+5:30	isoumya1602@gmail.comcom	160120736070	I.Sowmya	9.19502E+11	7.5	To learn something about CFD
2023/09/15 5:08:28 AM GMT+5:30	nausheenfirdouse40868@gmail.com	160120736069	Shaik Nausheen Firdouz	6300484356	8.86	I want know to learn more about cfd

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45 years

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Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Srihitha Malisetty*** with Roll No. ***1601-20-736-305***, has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini
Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

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A VALUE ADDED COURSE
on

Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr. ***Bharath Pol*** with Roll No. ***1601-20-736-015***, has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

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Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

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45 years

A VALUE ADDED COURSE

on

Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr./Ms./Mrs ***Mohammed Furqaan Jamal*** with Roll No. ***1601-20-736-029***, has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini
Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

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45 years

A VALUE ADDED COURSE
on

Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr./Ms./Mrs ***Mukund Balraj Vishwanath*** with Roll No. ***1601-20-736-031,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini
Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
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A VALUE ADDED COURSE
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Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr./Ms./Mrs *Ayushi Chaturvedi* with Roll No. ***1601-20-736-001,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini
Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

ASSOCIATE PROFESSOR & HEAD
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Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Banoth Suresh*** with Roll No. ***1601-20-736-106,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini

Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy

HOD - Dept of Mechanical Engineering

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Course Completion Certificate

This is to certify that Mr./Ms./Mrs ***Sri Chandana*** with Roll No. ***1601-20-736-072,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini

Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy

HOD - Dept of Mechanical Engineering

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Course Completion Certificate

This is to certify that Mr./Ms./Mrs ***Pranav*** with Roll No. ***1601-20-736-086,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini

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Dr. P. Prabhakar Reddy

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Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Afreen begum*** with Roll No. ***1601-20-736-061,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

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Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

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Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Putta Venu*** with Roll No. ***1601-20-736-110,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

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Coordinator

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Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Thumuganti Karthik*** with Roll No. ***1601-20-736-082,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

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Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

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Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Allagada Nagavishnu*** with Roll No. ***16012736089,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

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Assistant Professor - Dept. of Mechanical Engineering
Coordinator

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HOD - Dept of Mechanical Engineering

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Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Bhavani Sankar Chodavarapu*** with Roll No. ***160120736078,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini
Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

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This is to certify that Mr./Ms./Mrs. ***G Jashwanth*** with Roll No. ***1601-20-736-080,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

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Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

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Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Aditya Varupula*** with Roll No. ***1601-20-736-074,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

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Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

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Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Kummara Praneeth Ram*** with Roll No. ***1601-20-736-091,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini
Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

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Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Rishab Erramilli*** with Roll No. ***1601-20-736-093,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

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Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

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Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Chepuri Ashwini*** with Roll No. ***1601-20-736-304,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini
Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

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Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Shashi Kiran Mankala*** with Roll No. ***1601-20-736-103,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini
Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

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Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Rohith Chamanthula*** with Roll No. ***1601-20-736-303,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini
Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

ASSOCIATE PROFESSOR & HEAD
Department of Mechanical Engineering
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on

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Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Marikukala Dhana Nivas*** with Roll No. ***1601-20-736-020,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

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Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
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COMMITTED TO RESEARCH, INNOVATION AND EDUCATION
45 years

A VALUE ADDED COURSE
on

Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***T. Sai Samanvith*** with Roll No. ***1601-20-736-100,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini
Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
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on

Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***G Chandrakanth Singh*** with Roll No. ***1601-20-736-017,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini
Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
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COMMITTED TO RESEARCH, INNOVATION AND EDUCATION

45 years

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on

Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***I. Sowmya*** with Roll No. ***1601-20-736-070,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

Dr. Ch. Indira Priyadarshini
Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
HOD - Dept of Mechanical Engineering

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Computational Fluid Dynamics for Automobile and Aviation

Course Completion Certificate

This is to certify that Mr./Ms./Mrs. ***Shaik Nausheen Firdouz*** with Roll No. ***1601-20-736-069,*** has successfully completed value added course on Computational Fluid Dynamics for Automobile and Aviation, organised by DEPT OF MECHANICAL ENGINEERING from 24th July 2023 to 11th Nov 2023.

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Assistant Professor - Dept. of Mechanical Engineering
Coordinator

Dr. P. Prabhakar Reddy
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