FLUENT - Flow over an Airfoil- Step 2

Problem Specification
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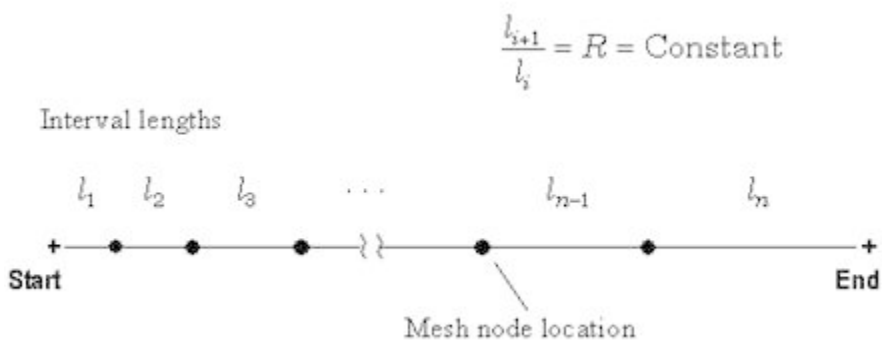
Step 2: Mesh Geometry in GAMBIT

Mesh Faces

We'll mesh each of the 3 faces separately to get our final mesh. Before we mesh a face, we need to define the point distribution for each of the edges that form the face i.e. we first have to mesh the edges. We'll select the mesh stretching parameters and number of divisions for each edge based on three criteria:

1. We'd like to cluster points near the airfoil since this is where the flow is modified the most; the mesh resolution as we approach the farfield boundaries can become progressively coarser since the flow gradients approach zero.
2. Close to the surface, we need the most resolution near the leading and trailing edges since these are critical areas with the steepest gradients.
3. We want transitions in mesh size to be smooth; large, discontinuous changes in the mesh size significantly decrease the numerical accuracy.

The edge mesh parameters we'll use for controlling the stretching are *successive ratio, first length* and *last length*. Each edge has a direction as indicated by the arrow in the graphics window. The *successive ratio R*is the ratio of the length of any two successive divisions in the arrow direction as shown below. Go to the index of the GAMBIT User Guide and look under ***Edge>Meshing*** for this figure and accompanying explanation. This help page also explains what the *first* and *last lengths* are; make sure you understand what they are.



Operation Toolpad > Mesh Command Button **> Edge Command Button** **> Mesh Edges**

Select the edge GA. The edge will change color and an arrow and several circles will appear on the edge. This indicates that you are ready to mesh this edge. Make sure the arrow is pointing upwards. You can reverse the direction of the edge by clicking on the ***Reverse*** button in the *Mesh Edges* menu. Enter a ratio of 1.15. This means that each successive mesh division will be 1.15 times bigger in the direction of the arrow. Select Interval Count under ***Spacing***. Enter 45 for ***Interval Count***. Click ***Apply***. GAMBIT will create 45 intervals on this edge with a successive ratio of 1.15.

For edges AB and CG, we'll set the *First Length* (i.e. the length of the division at the start of the edge) rather than the *Successive Ratio*. Repeat the same steps for edges BC, AB and CG with the following specifications:

Edges	Arrow Direction	Successive Ratio	Interval Count
GA and BC	Upwards	1.15	45

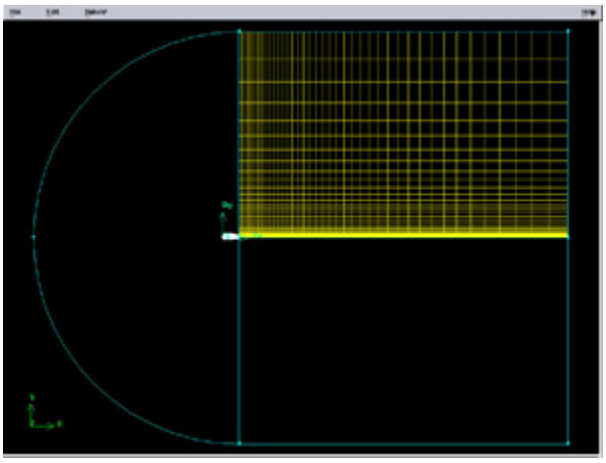
Edges	Arrow Direction	First Length	Interval Count
AB and CG	Left to Right	0.02*c*	60

Note that later we'll select the length at the trailing edge to be 0.02*c* so that the mesh length is continuous between IG and CG, and HG and CG.
Now that the appropriate edge meshes have been specified, mesh the face rect1:

**Operation Toolpad > Mesh Command Button > Face Command Button > Mesh Faces **

Select the face rect1. The face will change color. You can use the defaults of ***Quad*** (i.e. quadrilaterals) and ***Map***. Click ***Apply***.

The meshed face should look as follows:



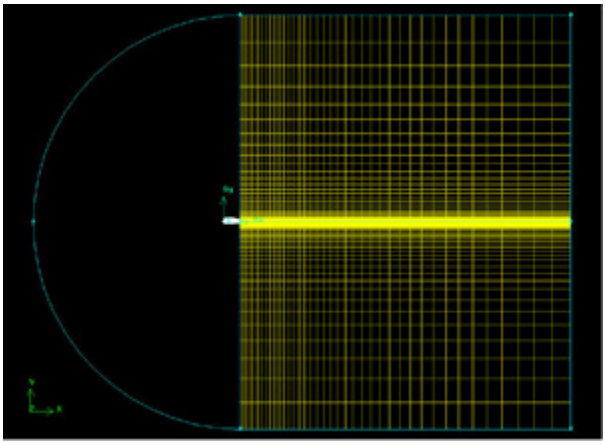
Higher Resolution Image

Next mesh face rect2 in a similar fashion. The following table shows the parameters to use for the different edges:

Edges	Arrow Direction	Successive Ratio	Interval Count
EG and CD	Downwards	1.15	45

Edges	Arrow Direction	First Length	Interval Count
DE	Left to Right	0.02*c*	60

The resultant mesh should be symmetric about CG as shown in the figure below.



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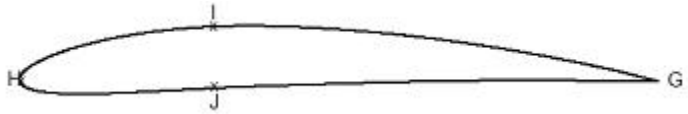
Split Edges

Next, we will split the top and bottom edges of the airfoil into two edges so that we have better control of the mesh point distribution. Figure of the splitting edges is shown below.



We need to do this because a non-uniform grid spacing will be used for *x<0.3c* and a uniform grid spacing for *x>0.3c*. To split the top edge into HI and IG, select

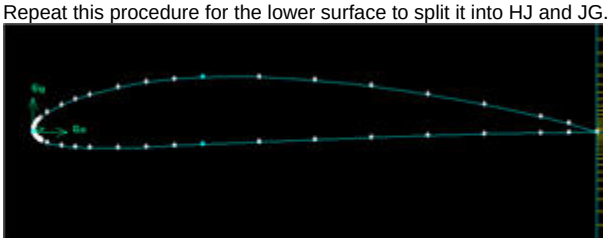
Operation Toolpad > Geometry Command Button > Edge Command Button > Split/Merge Edge

Make sure Point is selected next to Split With in the *Split Edge* window.

Select the top edge of the airfoil by Shift-clicking on it.

We'll use the point at *x*=0.3*c* on the upper surface to split this edge into HI and IG. To do this, enter 0.3 for x: under Global. If your *c* is not equal to one, enter the value of 0.3**c* instead of just 0.3.For instance, if *c*=4, enter 1.2. From here on, whenever you're asked to enter (some factor)**c*, calculate the appropriate value for your *c* and enter it.
Click Apply. You will see a message saying "Edge edge.1 was split, and edge edge.3 created" in the *Transcript* window.

Repeat this procedure for the lower surface to split it into HJ and JG. Use the point at *x*=0.3c on the lower surface to split this edge.



Higher Resolution Image

Finally, let's mesh the face consisting of circ1 and the airfoil surface. For edges HI and HJ on the front part of the airfoil surface, use the following parameters to create edge meshes:

Edges	Arrow Direction	Last Length	Interval Count
HI	From H to I	0.02*c*	40
HJ	From H to J	0.02*c*	40

For edges IG and JG, we'll set the divisions to be uniform and equal to 0.02*c*. Use *Interval Size* rather than *Interval Count* and create the edge meshes:

Edges	Arrow Direction	Successive Ratio	Interval Size
IG and JG	Left to Right	1	0.02*c*

For edge AF, the number of divisions needs to be equal to the number of divisions on the line opposite to it, in this case, the upper surface of the airfoil(this is a subtle point; chew over it). To determine the number of divisions that GAMBIT has created on edge IG, select

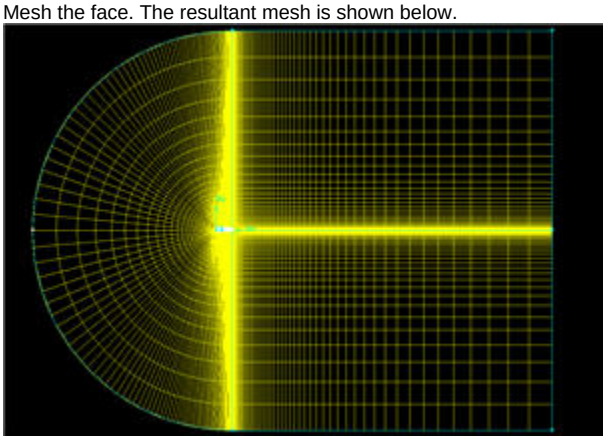
Operation Toolpad > Mesh Command Button **> Edge Command Button** **>Summarize Edge Mesh**

Select edge IG and then ***Elements*** under ***Component*** and click ***Apply***. This will give the total number of nodes (i.e. points) and elements (i.e. divisions) on the edge in the *Transcript*window. The number of divisions on edge IG is 35. (If you are using a different geometry, this number will be different; I'll refer to it as *NIG*). So the *Interval Count* for edge AF is *NHI+NIG*= 40+35= **75**.

Similarly, determine the number of divisions on edge JG. This comes out as 35 for the current geometry. So the *Interval Count* for edge EF is **75**.
Create the mesh for edges AF and EF with the following parameters:

Edges	Arrow Direction	First Length	Interval Count
AF	From A to F	0.02*c*	40+*NIG*
EF	From E to F	0.02*c*	40+*NJG*

Mesh the face. The resultant mesh is shown below.



Higher Resolution Image

Go to Step 3: Specify Boundary Types in GAMBIT

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