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EAS 4703C

CFD simulation on re-entry vehicles

Assignment:

- 2D supersonic flow simulation on streamlined body (high BC) and on a blunt body (low BC).
- you are required to get the pressure, temperature, velocity, Mach number and density contours and observe the formation of attached/oblique on high BC body and detached shock waves on low BC body

High BC Body:

A 3D cone was created to simulate oblique shockwaves extending from the leading edge at supersonic speeds. A fine mesh was created in front of the body in order to accurately display this wave, however the mesh behind the body was left relatively course in an attempt to speed up computing time. The input velocity was set to Mach 5 (1715 m/s). The contours provided are displayed on a plane at the center of the cone on the x-y axis, providing a cross section of the flow around the body in the enclosure.

Figure 1a & 1b: 3D Body/Enclosure Design and Mesh

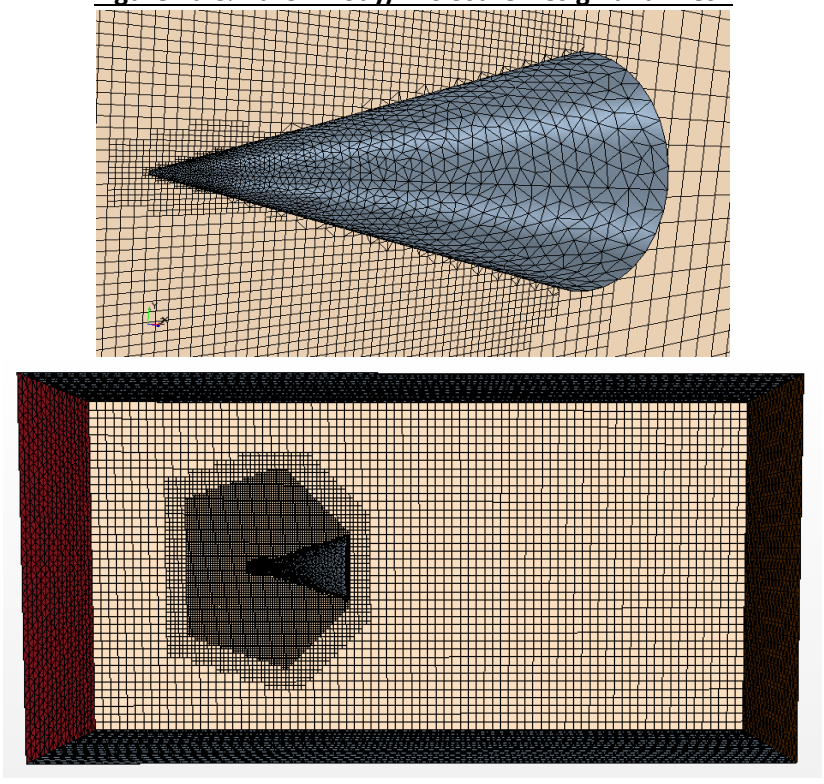
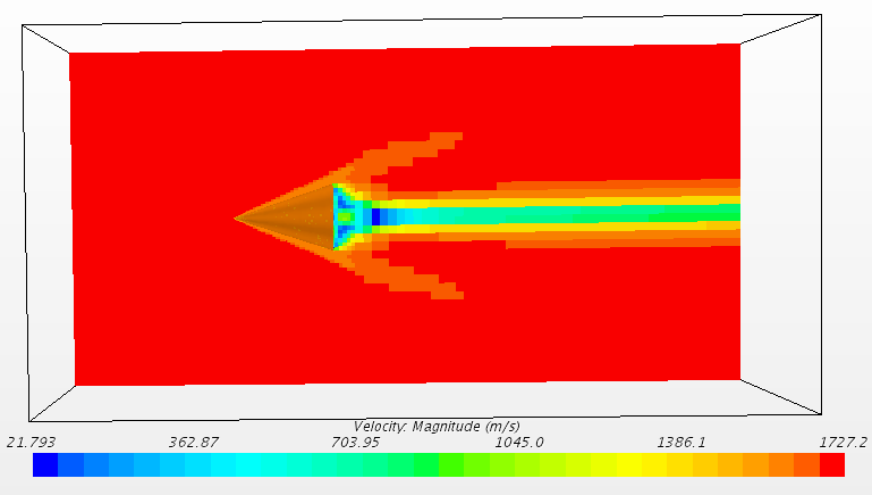


Figure 2a & 2b: Velocity and Mach Number Contours



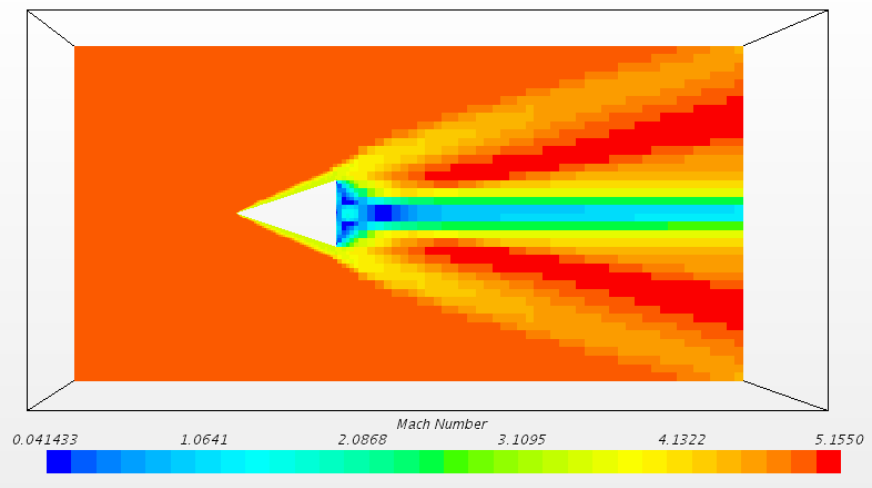
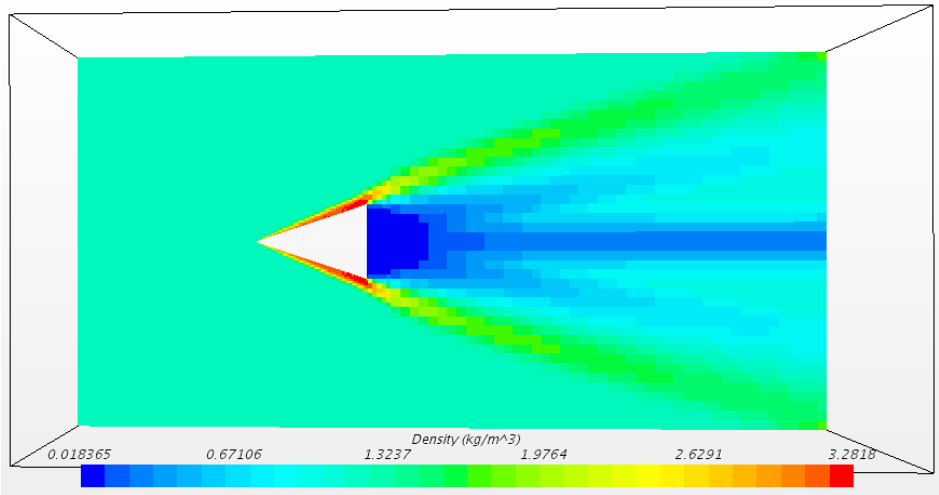


Figure 2c & 2d: Density and Pressure Contours



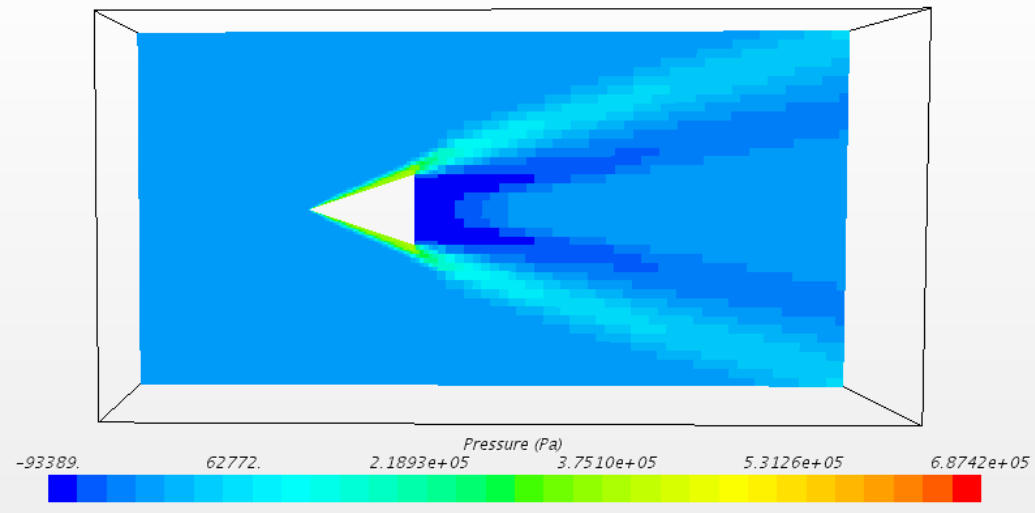
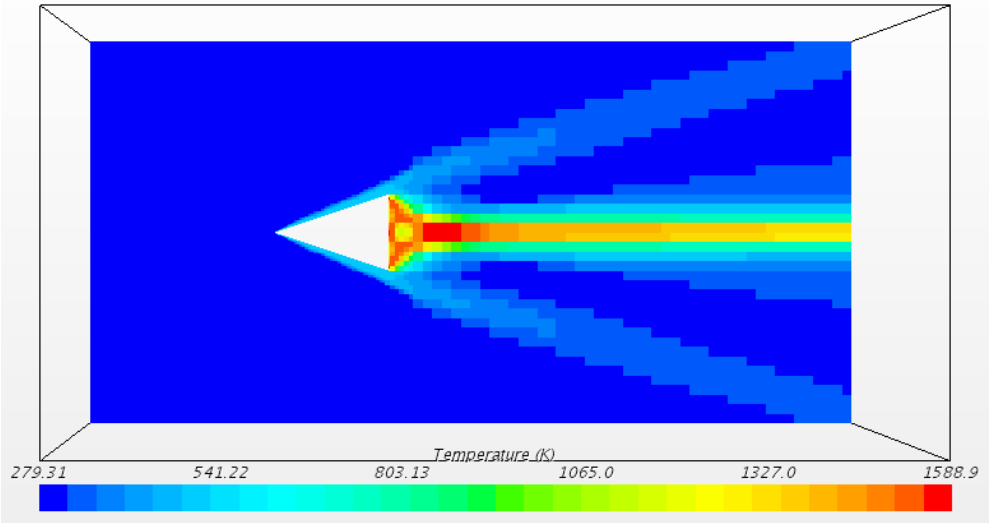


Figure 2e: Temperature Contour



The figures show the presence of an oblique shockwave, although not at as big of an angle as it ideally would be. The flow does not notice the presence of the body (no change in any of the values) until it reaches the leading edge of the body: a characteristic principle of supersonic flow.

Low BC Body:

A 3d body modeled after the Apollo missions' command module was created to simulate separated shockwaves in front of the leading edge at supersonic speeds. Similar to the High BC body, a fine mesh was created in front of the body in order to accurately display this wave, however the mesh behind the body was left relatively course in an attempt to speed up computing time. The input velocity was set to Mach 2 (686 m/s). The contours provided are displayed on a plane at the center of the cone on the x-y axis, providing a cross section of the flow around the body in the enclosure.

Figure 3a & 3b: Body/Enclosure Design and Mesh

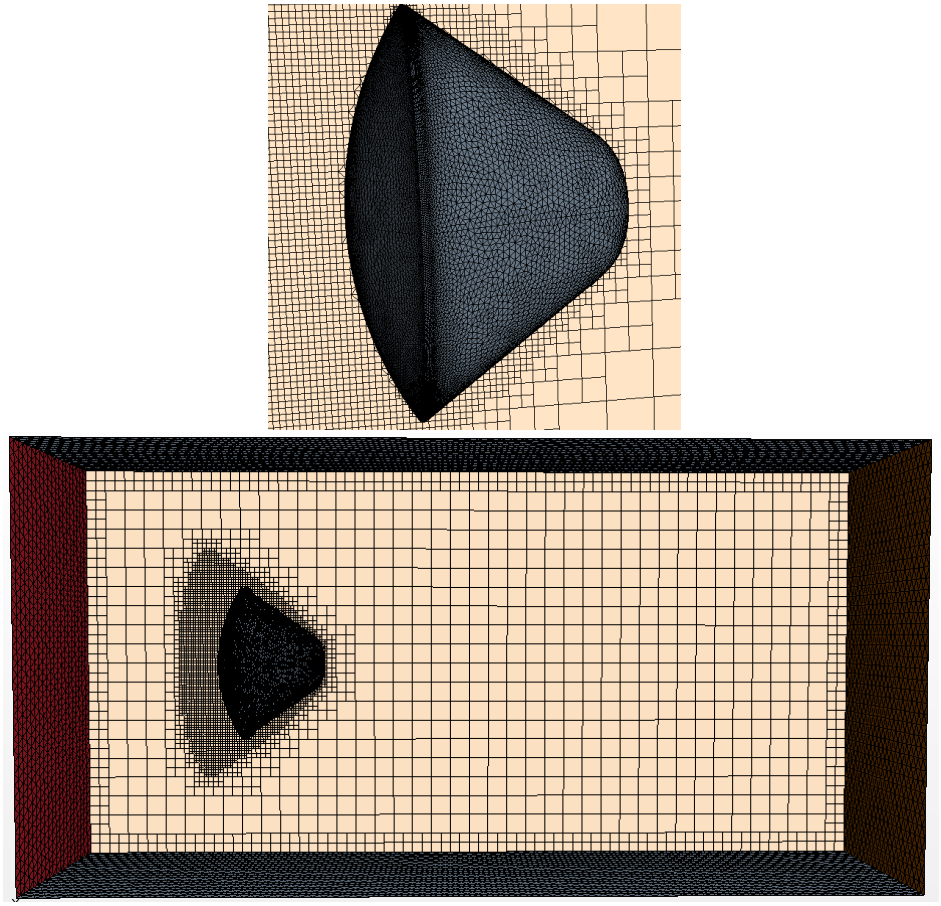
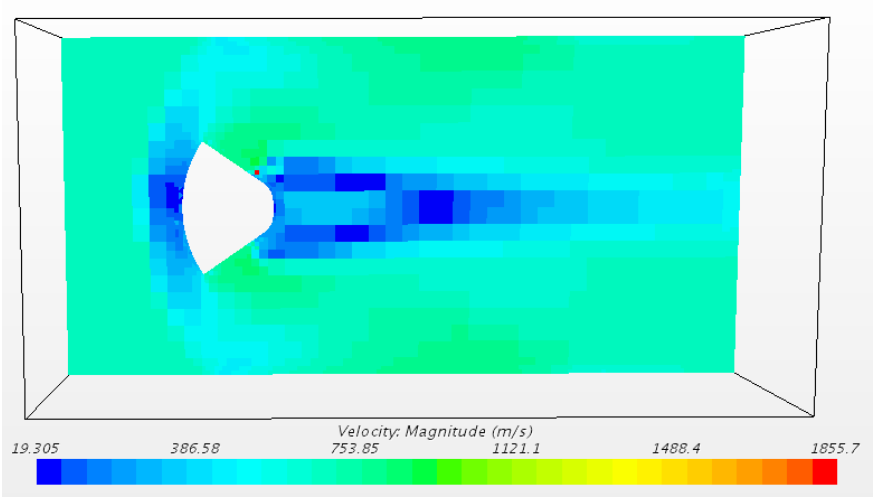


Figure 4a & 4b: Velocity and Mach Number Contours



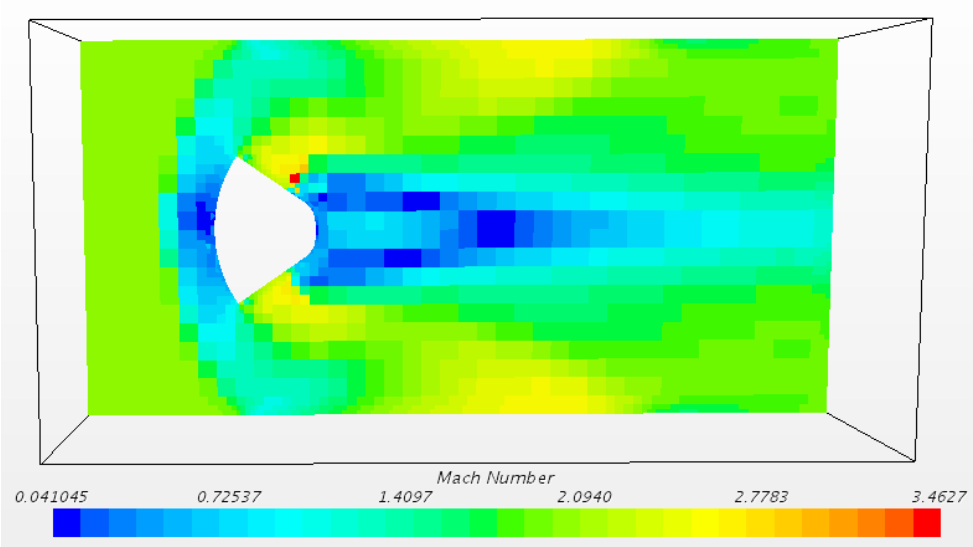
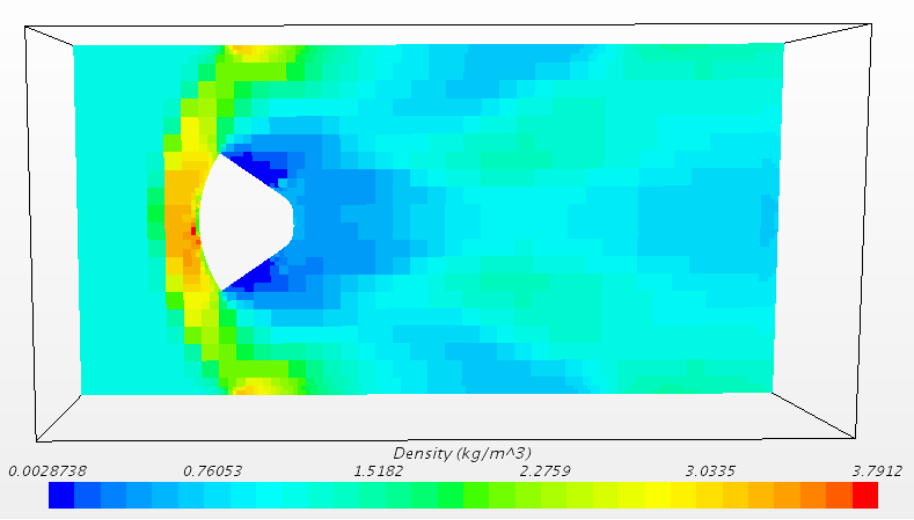


Figure 4c & 4d: Density and Pressure Contours



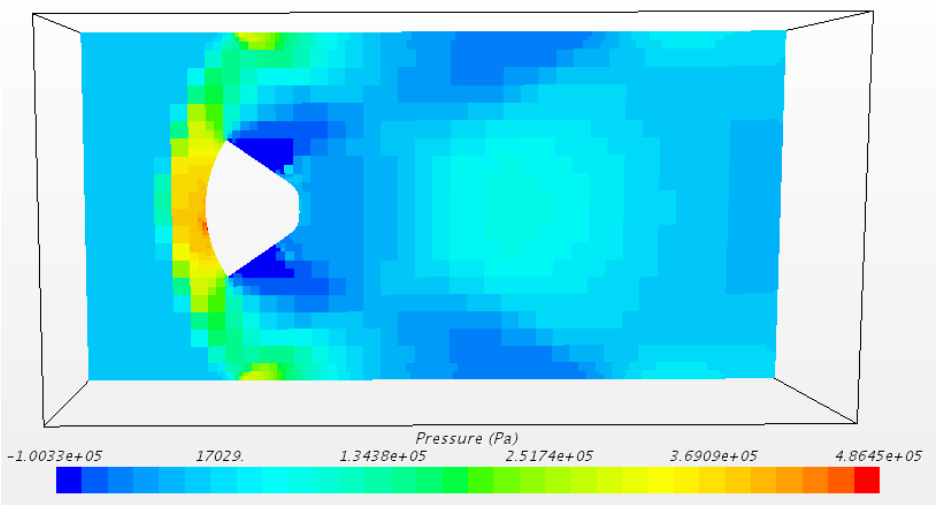
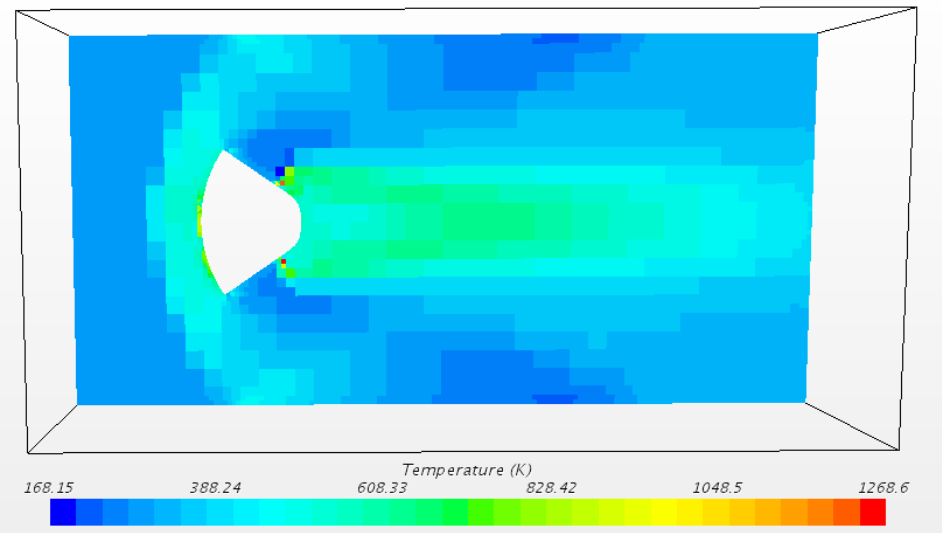


Figure 4e: Temperature Contour



The figures show the presence of a separated shockwave, although very rough. The flow does not notice the presence of the body (no change in any of the values) until it reaches the leading edge of the body: a characteristic principle of supersonic flow.

The Low BC process did not converge, and thus provided unrefined/ “blocky” results.