3D Bifurcating Artery: Lecture Outline

Introduction

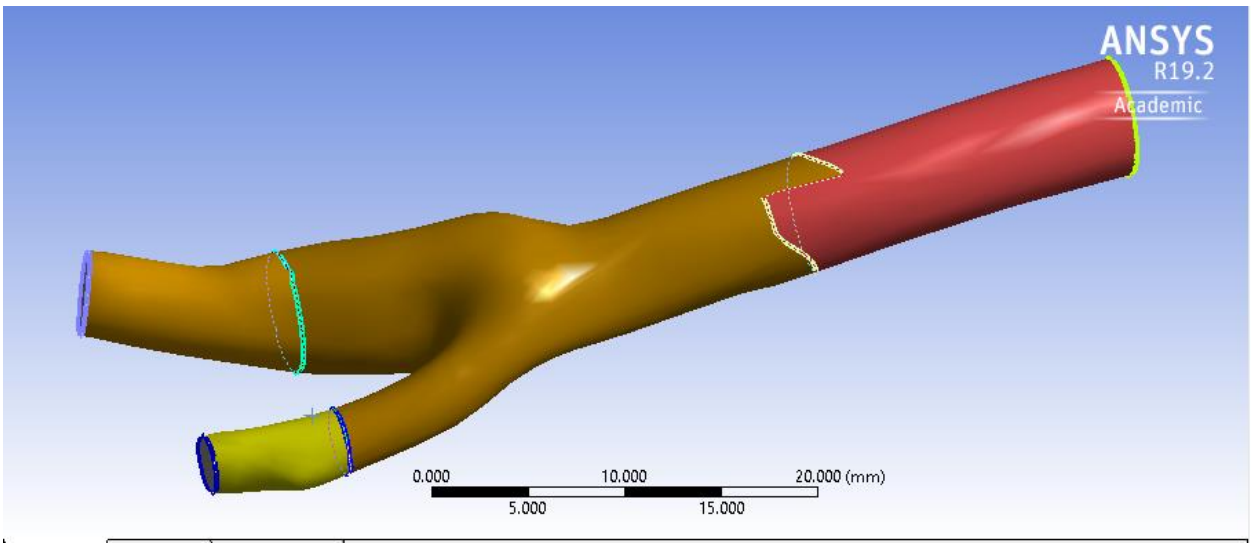
- Open Workbench 19.2
- Double click/drag Fluent into Project Schematic Box

Geometry

- Re-name Fluent analysis: Bifurcating Atery
- Start SpaceClaim
- File > Open>select All files format>bif_artery.STEP
    - Alternatively, Right click Geometry>Import Geometry>Browse
- Save project in wbpj format

Mesh

- Double click mesh/ Right click>Edit
- Right click Model in tree>Insert>Virtual Topology
- Hold down left mouse button and sweep through the surfaces
- Hold down center mouse button to rotate model
- Hold down control button and sweep through remaining surfaces using left mouse button
- Right click on highlighted regions>Insert>Virtual Cell
- Highlight remaining regions as shown and repeat the above step



- Select Face select Option

- Left click on Inlet in model>Right click>Create Named Selection>Type inlet1
- Repeat for outlet1 and outlet2
- Left click anywhere on artery wall>Extend to limits
- Right click>Create Named Selection>Type wall_artery
- Select Body option>Select body>right click>Named Selection>Type fluid_zone
- Mesh>Insert>Sizing
    - Geometry>Select Body
    - Element size = 1e-3m
        - If units are not in m, Units>Metric(m,kg,N,s,V,A)
- Mesh>Insert>Inflation
    - Geometry>Select Body
    - Boundary Scoping Method>Named Selections
    - Boundary>wall_artery>Hit Enter
    - Inflation Option>Total Thickness
    - Maximum Thickness>6e-4
- Mesh>Sizing>Min Size>5e-4
- Generate Mesh

Physics Setup

- Start FLUENT
    - Double precision
- General>Time>Transient
- Materials>Fluid
    - Change name from air to blood
    - Set Density to 1060 kg/m3
    - Viscosity>Carreau

Coefficients:	Input Value
Time Constant, lambda (s)	3.313
Power-Law Index n	0.3568
Zero Shear Viscosity (kg/m-s)	0.056
Infinite Shear Viscosity (kg/m-s)	0.0035

- User Defined>Functions>Compiled
    - Add UDF file vinlet_udf.c>Build>Read

- Boundary Conditions>Inlet>Velocity Inlet> Edit>Velocity Magnitude>Change "Constant" to "udf inlet_velocity".
- Outlet1>Pressure Outlet>Edit>Gauge Pressure 13332
- Outlet2 same as outlet1
- Setting Up Physics>Model Specific>Discrete Phase Models>Injections
    - Injections>Create>Change "Particle Type" to Massless>Input the coordinates (see the table below)
    - Repeat the steps above to inject another particle

Injection	x coordinates	y coordinates	z coordinates
injection-0	0.001183	0.006242	-0.0318313
injection-1	0.002758	0.004548	-0.0318313

- Open Spaceclaim>Measure>Mass Properties
    - Note down Total Surface Area
- Go back to Setup>Reference values
    - Type in the values given below

Parameter	Input Value
Area(m^2)	0.0013245
Density(kg/m^3)	1060
Velocity (m/s)	0.1

- Report Monitors>New>Force Report>Drag
    - Select wall_artery
- Solution Initialization>Hybrid Initialization>Initialize
- Calculation Activities>Create>Solution Data Export
    - Change file type to “CDAT for CFD Post and Ensight”
    - Select the following
        - Static Pressure
        - Total Pressure
        - Velocity Magnitude
        - X Velocity
        - Y Velocity

        - Z Velocity
        - Wall Shear Stress
    - Change Frequency (Time Steps) to 5
- Calculation Activities>Create>Particle Data History Export
    - Select both injections
- Run Calculation
    - Set Time Step Size(s) to 0.01
    - Set Number of Time Steps to 50
    - Set Maximum Iterations/Time Step to 200
    - Calculate

Numerical Results (CFDPost)

- Open>First .cas file
- Right click wall_artery>Edit>Render
    - Set Transparency to 0.7

Creating Velocity Vectors

- Toolbar>Create Vector
    - Locations>fluid_zone

Adding and Animating Particle Path Lines

- File>Import>Fluent Particle Track File
- Fluent PT for Massless>Color>Mode>Variable
    - Variable>Velocity
- Symbols>Show symbols>Current Time
    - Set scale to 0.5
- In Toolbar>Animation
    - Select Fluent PT for massless
    - Hit Play
    - To Save video, select save video option
    - Change speed by moving the slider accordingly

Plotting and Animating Wall Shear on Artery Wall

- Turn off FLUENT PT for Massless
- Click on Location > select Surface Group
    - Name it Artery Wall
    - Geometry>Location>wall_artery
    - Color>Mode>Variable
        - Variable>Wall shear
- To animate

    - Toolbar>Animation
    - Repeat the process from the previous tutorial to produce a video

Creating a Sweep for Velocity Profiles at different sections

- Turn off artery_wall
- Location>Isosurface
    - Geometry>Variable>Z
    - Value> drag the slider to the most left for smallest value
- Color>Mode>Variable
    - Variable>Velocity
- Click on Animation Icon
- Click on XY Plane for animation
- Repeat process from previous tutorial videos

Verification & validation