MECH 6024, MECH 5124
COMP MEHTODS IN ADDITIVE MFG
Spring 2020
Final Take Home Examination
Due: Friday May 1st 2020 by 11 pm on Blackboard
(You may submit anytime until 11 pm on May 1, 2020. No extensions will be given beyond this time)

- ***This is an individual take home exam. You are expected to work independently*. You can consult any books, class notes, library material and online material, but you may not consult each other or obtain help from anybody else.**
- **Clearly indicate the steps followed in a separate document and comment the code to understand the steps performed.**
- **Submit the executable code and the HAND-WRITTEN STEPS and OUTPUT in a zip archive on Blackboard before 11 pm on due date. Zip archives should be named in LastName_FirstName.zip format.**

The part shown below is to be manufactured using Additive Manufacturing process with the build direction along the Z-Axis (slices parallel to the X-Y plane) as shown in the figure. The following questions are based on the geometry below:

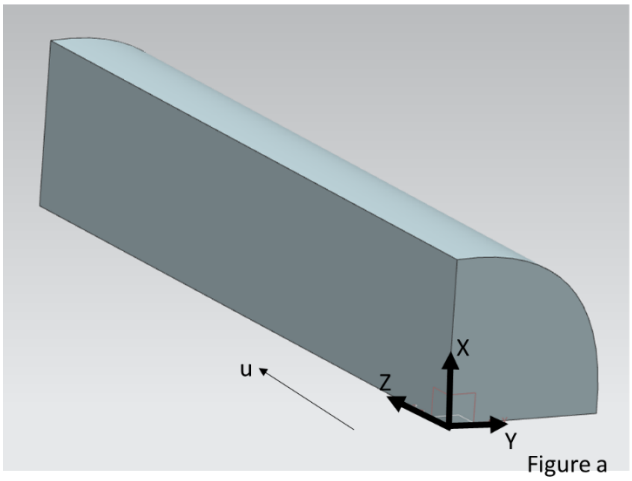


Figure a

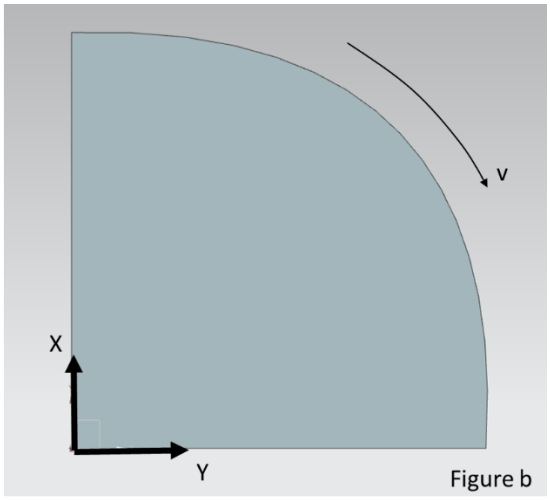


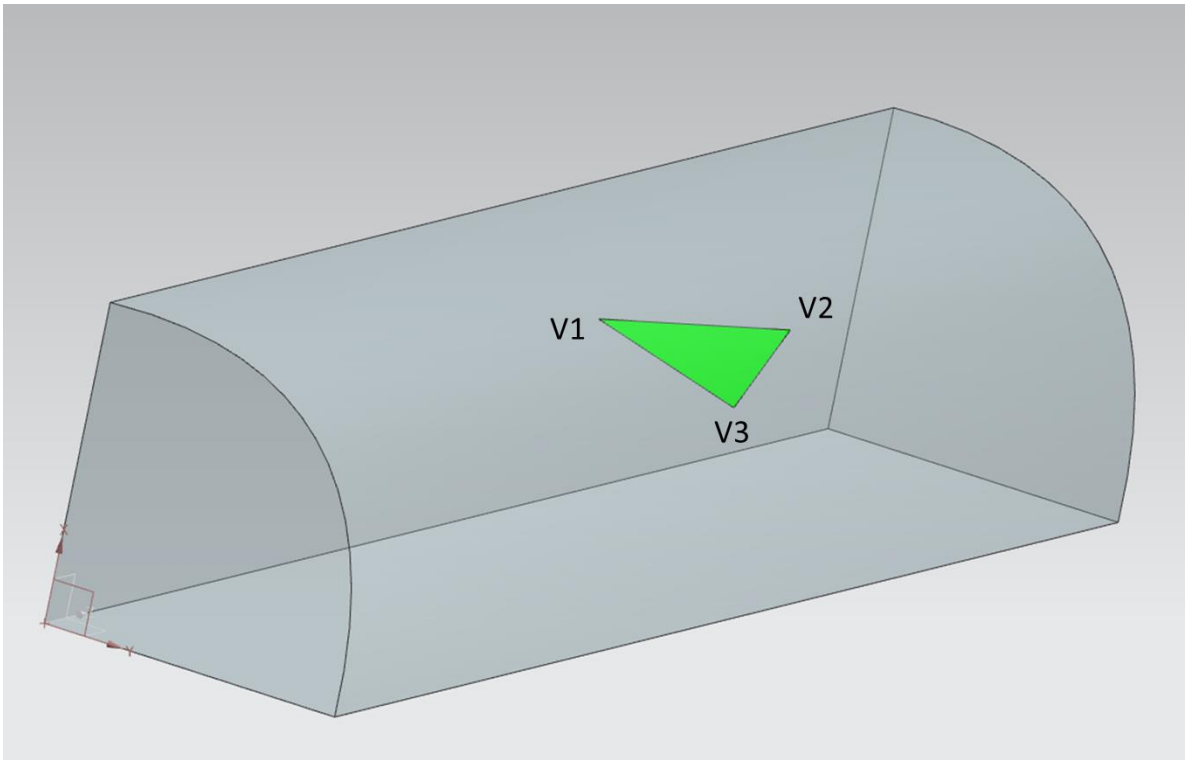
Figure b

The quarter cylinder-like profile surface is generated by sweeping a NURBS curve of order 3 on the X-Y plane (Z=0) and sweeping this curve along a straight line 50 units long along the Z-axis. The control points of the curve on the X-Y plane at Z= 0 are as following:

$$P_{00} = [10, 0, 0], \qquad P_{10} = [10, 10, 0], \qquad P_{20} = [0, 10, 0]$$

The weights h_i of the controls points are [1, 2, 1] respectively. The "*v*" direction is along the X-Y plane and the "*u*" direction is along the Z-axis as shown in the figure.

Q1. Find the remaining control points and knot vectors along the *u* and *v* direction and formulate the NURBS equation of the surface. Plot the NURBS surface in MATLAB or using any other software.



Q2. This part model is converted to an STL file and a single planar triangular facet (green) that represents part of the cylinder-like surface is shown in the figure. The three vertices of the green STL facet that lie on the NURBS surface are V1 (u =0.4, v=0.3); V2 (u =0.6, v=0.5); V3 (u =0.5, v=0.7). Plot this triangular facet on the NURBS surface. Using the Vertex Translation Algorithm (VTA) paper (presented and discussed in class and posted on Blackboard), find the maximum chordal error associated with this facet to the closest NURBS surface.

Q3. Based on the NURBS surface point associated with the maximum chordal error, replace this single STL facet with **3** new facets that reduce the chordal error. Provide the coordinates of the vertices of the new facets in both cartesian (x, y, z) and parametric (u, v) format. Calculate the unit outward normal vector for the newly generated facets. Calculate one average chordal error value for each of these facets based on approximate centroid of the facets on the u-v space. Prove that the chordal error value was reduced. Plot the newly generated facets along with the NURBS surface.

Hint: Please referring to VTA_Joural_Paper.pdf on Blackboard for chordal error and VTA