MECH-6024, MECH-5124

Computational Methods in Additive Manufacturing I

Assignment 2 (100 points)

To be worked in groups of two, include both names on the final report. Do not consult other groups.

Due on March 3rd, 2020 (In Class)

Note: Show all detailed calculations and workings.

- **Questions should be solved using MATLAB or equivalent programming language and a report should be compiled with all of the necessary solutions and plots.**
- **Clearly indicate the steps followed and comment the code for full grade.**
- **Submit a zip archive of the code and report on blackboard. Zip archives should be submitted as LastName_FirstName.zip for only one of the students per group.**

1. (20pts)

A polyhedron is defined as having 11 faces composing of 9 unique vertices

The vertices are listed in the table below:

	x	y	z
v1	4	6	-5
v2	14	6	-5
v3	4	16	-5
v4	4	6	5
v5	14	16	5
v6	4	16	5
v7	4	6	15
v8	14	6	15
v9	14	16	15

The faces are planar polygons composed of the following vertices listed in order such that the normal faces outward using typical right-hand convention.

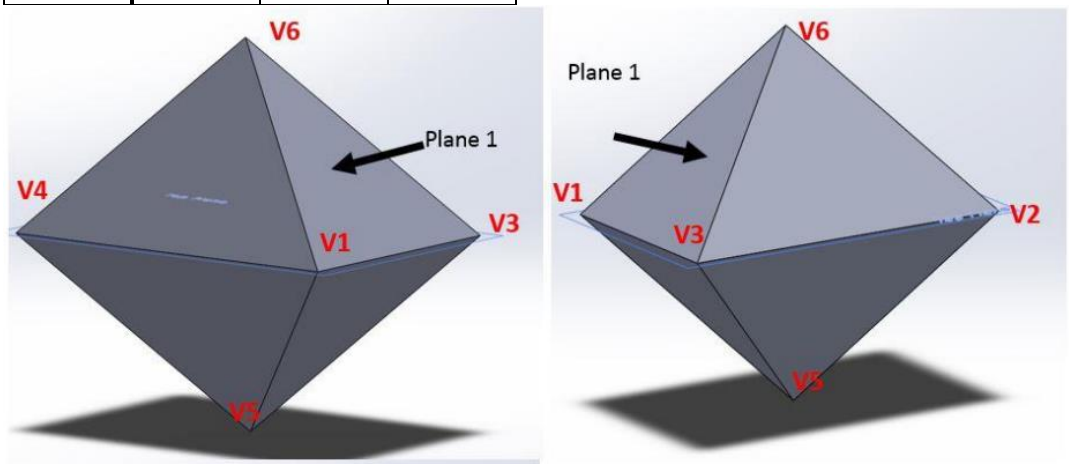
f1	v1	v3	v2		
f2	v1	v2	v4		
f3	v2	v3	v5		
f4	v7	v6	v3	v1	v4
f5	v2	v5	v4		
f6	v3	v6	v9	v5	
f7	v4	v5	v8		
f8	v4	v8	v7		
f9	v5	v9	v8		
f10	v6	v7	v9		
f11	v7	v8	v9		

Calculate the exact volume of this polyhedron using the method described in class

2. (10pts)

The vertices of an octahedron are given below

	x	y	z
V1	5	1	0
V2	5	1	2
V3	6	1	1
V4	4	1	1
V5	5	0	1
V6	5	2	1



Project the octahedron onto the plane formed by the three points **V1**, **V3**, and **V6.**

3. (25pts)

(a) Generate and plot a Hermite cubic curve for the following parameters:
Start Point **P1= (4, 2, 6)**, Start Tangent **M1=(3, 1, -1)**, End Point **P2=(2, 8, 4)**, End Tangent **M2=(-1, 1, -1)**.
Also calculate the tangent vector and the unit tangent vector for this curve at **u=0.6**.
(b) Generate and plot a Hermite cubic curve having C1 continuity with the end point of the curve in (a).
For this second curve, use End Point **P2=(-2, 5, 4)**, End Tangent **M2=(1, 2, -1)**.
Plot both curves in a single MATLAB plot.

4. (25pts)

(a) For the Bezier control points given below, generate and plot the curve using MATLAB:
A=(1, 1, 1), **B=(1, 3, 3)**, **C=(3, 2, 1)**, **E=(2, 4, 2)**

(b) For the curve in (a), add a duplicate point **D** in the same location as point **C**, resulting in the Bezier control points given below:
A=(1, 1, 1), **B=(1, 3, 3)**, **C=(3, 2, 1)**, **D=(3, 2, 1)**, **E=(2, 4, 2)**
Generate and plot the curve using MATLAB. What is the degree of the new curve? Calculate the value of the tangent vector for this curve at **u=0**, **u=0.5**, **u=0.75**, and **u=1**.

(c) For the curve in (b), change the coordinates of point **B** to **(0, 5, -2)** and plot this curve along with the curve from (b) using MATLAB. Explain whether this change affects the shape of the curve locally or globally.

5. (20pts)

Determine a Bezier curve of **degree 3** that approximates a quarter circle centered at **(0, 0)**. The end points of the quarter are **(0, 5)** at **u=0** and **(-5, 0)** at **u=1**. Ensure that the curve passes through the exact quarter circle at **u=0.5**. Plot the generated Bezier curve using MATLAB. Calculate the radial error of the Bezier curve at **u=0.25** and **u=0.75**. Also determine the maximum radial deviation and the corresponding u value of the curve from the ideal circle.