MECH 6024; MECH 5124
Comp. Methods in Additive Manufacturing
Individual Assignment – 4
Due: March 31st, 2020 (On Blackboard by 9 pm)

- **This is an individual assignment.**
- **All the questions should be plotted using MATLAB (or any other programming language). Clearly indicate the steps followed and comment the code wherever necessary.**
- **Submit the hand-written steps and the printed graphical output as a scanned document.**
- **Submit the executable MATLAB code in a zip archive on Blackboard. Zip archives should be named in LastName_FirstName.zip format.**

1. Determine a point on a bicubic surface patch corresponding to $\mathbf{u = 0.35, w = 0.45}$ and $\mathbf{u = 0.65, w = 0.75}$.
The position vectors for four corner points are:
$\mathbf{P(0,0) = [-100\ 0\ 100]}$ $\mathbf{P(0,1) = [-100\ -100\ -100]}$
$\mathbf{P(1,0) = [100\ -100\ 100]}$ $\mathbf{P(1,1) = [100\ 0\ -100]}$
The tangent vectors are:
$\mathbf{P^u(0,0) = [100\ 100\ 0]}$ $\mathbf{P^u(0,1) = [1\ 1\ 0]}$,
$\mathbf{P^u(1,0) = [1\ -1\ 0]}$ $\mathbf{P^u(1,1) = [1\ -1\ 0]}$
$\mathbf{P^w(0,0) = [0\ 10\ -10]}$ $\mathbf{P^w(0,1) = [0\ -1\ -1]}$,
$\mathbf{P^w(1,0) = [0\ 1\ -1]}$ $\mathbf{P^w(1,1) = [0\ -1\ -1]}$
and the twist vectors are:
$\mathbf{P^{uw}(0,0) = [0\ 0\ 0]}$ $\mathbf{P^{uw}(0,1) = [0.1\ 0.1\ 0.1]}$,
$\mathbf{P^{uw}(1,0) = [0.1\ -0.1\ -0.1]}$ $\mathbf{P^{uw}(1,1) = [0\ 0\ 0]}$
Plot the patch using MATLAB and determine unit normal vector at $\mathbf{u = 0.85, w = 0.95}$

2. Generate a **5x3** (4^{th} degree in $\mathbf{u}$ direction and 2^{nd} degree in $\mathbf{w}$ direction) Bezier patch having following control points:

$\mathbf{B_{00}[0,0,0]}$,	$\mathbf{B_{01}[0,3,2]}$,	$\mathbf{B_{02}[0,5,0]}$
$\mathbf{B_{10}[2,0,3]}$,	$\mathbf{B_{11}[2,3,3]}$,	$\mathbf{B_{12}[2,5,3]}$
$\mathbf{B_{20}[4,0,5]}$,	$\mathbf{B_{21}[4,3,5]}$,	$\mathbf{B_{22}[4,5,5]}$
$\mathbf{B_{30}[6,0,4]}$,	$\mathbf{B_{31}[6,3,4]}$,	$\mathbf{B_{32}[6,5,4]}$
$\mathbf{B_{40}[8,0,0]}$,	$\mathbf{B_{41}[8,3,2]}$,	$\mathbf{B_{42}[8,5,0]}$

(a) Plot the Bezier surface in MATLAB
(b) For the generated surface, calculate $\mathbf{P^u}$ and $\mathbf{P^w}$ at $\mathbf{u = 0.35, w = 0.45}$ and calculate the unit surface normal at this point.

3. A cylindrical surface is generated by sweeping a quarter circle in the **x-y plane** along the **z-axis** by 4 units as shown in the accompanying figure. The quarter circle has a unit radius and is centered at **(0, 0, 0)**. Represent the cylindrical surface as a NURBS surface. For the NURBS patch indicate the following:

a) Order of the curve, control points and knot vectors for the base circle on x-y plane (**v direction**).
b) Control points for the upper circle of the cylinder.
c) Order of the curve, knot vector and control points in the "**u**" direction along the z axis.

d) Formulate the NURBS equation for the cylinder and calculate the actual x and y values of the NURBS patch at u=0.5, v=0.5. Calculate the radius of the cylinder at this point by finding the shortest distance of this point from the z axis. Comment on the accuracy of radius obtained.

e) Plot the NURBS surface patch using MATLAB.