INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR
M. E. (Mechanical) 2nd Semester Final Examination, 2014
Geometric Modeling for CAD (ME-1009)

**Time: 3 Hours**   **Full Marks: 70**

Answer Q. No. 1 (compulsory) and any FOUR from the rest.
Use SINGLE answer-script
Refer the section 'Given data' wherever necessary

1 (a) Write an AutoLISP program to draw automatic diagram of ball bearing on AutoCAD. Taking the ball diameter (d) as the user input, draw the four circles with diameters D1 = 2d, D2= 4d, D3= 6d and D4=8d. If D4 is less than equal to 60 mm then use 8 balls, for D4= 60 mm to 80 mm use 10 balls, for program should not allow more than 80 mm for D4. (To mention here, this is not as per the dimensions of an actual ball-bearing)
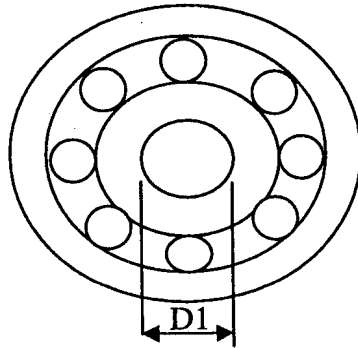
(b) Write a graphics program in MATLAB to display a cubic spline curve with its necessary user input. Now write a program to draw the surface of revolution by revolving the above cubic spline curve around X-axis for full 360^0 revolution.

[7+7]

2 (a) Derive the equation of the normal to the spherical surface (of unit radius) given by:
$S(u,v) = [\ \cos(u)\sin(v)\quad \sin(u)\sin(v)\quad \cos(v)\ ]$; u,v varies from 0 to 2Π.

(b) What is a developable surface? What is its importance in sheet-metal industry? Check the above surface is developable or not.

[6+8]

3. (a) What are surface geodesics? Explain with diagram.
(b) Explain mathematically how distance between two points (on curved path) on a curved surface can be found out.
(c) Derive the equation of linear Coon's surface and then write it in matrix form. Use necessary sketch.

[3+3+8]

4. (a) Explain mathematically how a B-spline curve can be made to pass through four given points, with suitable diagram. Also explain how the parameter u be subdivided for the above.

(b) Prove that for a cubic Bezier curve:

$$P''\left(\frac{1}{2}\right) = 3(P_0 - P_1 - P_2 + P_3)$$

[6+8]

5. (a) Derive the basis function $N_{10,3}(u)$ for the uniform B-Spline curve with $n+1=12$ and $k=3$.

(b) Using suitable sketch show the difference between a Bezier curve and a B-spline curve for the following effects:
   (i) shifting an intermediate point
   (ii) putting multiple vertices at a same point.
   (iii) Changing the number of control points.

[11+3]

6. (a) Derive the mathematical criterion for curvature continuity for joining two Bezier curves end-to-end, one with 4 control points another with 5 control points.

(b) Explain with suitable sketch the C^1 continuity criterion for joining a cubic spline curve and a cubic Bezier curve end-to-end.

[8+6]

7. (a) With a neat sketch discuss two types of tool path generation program (TPG).
   (b) What is the main difference between primitives and instances?
   (c) Explain the Euler's formula for a truncated pyramid.
   (d) What is topology? Why is it important in CAD, explain with figure.
   (e) Explain the CSG tree for a real component.

[3+2+3+3+3]

GIVEN DATA

1. Cubic spline basis functions :

[$(2u^3-3u^2+1)$ $(-2u^3+3u^2)$ (u^3-2u^2+u) (u^3-u^2)]

2. B-Spline recursive formula :

$$N_{i,k} = N_{i,k-1}(u) \times \frac{(u - u_i)}{(u_{i+k-1} - u_i)} + N_{i+1,k-1}(u) \times \frac{(u_{i+k} - u)}{(u_{i+k} - u_{i+1})}$$