MAEG 5710

Computer-Aided Design and Manufacturing

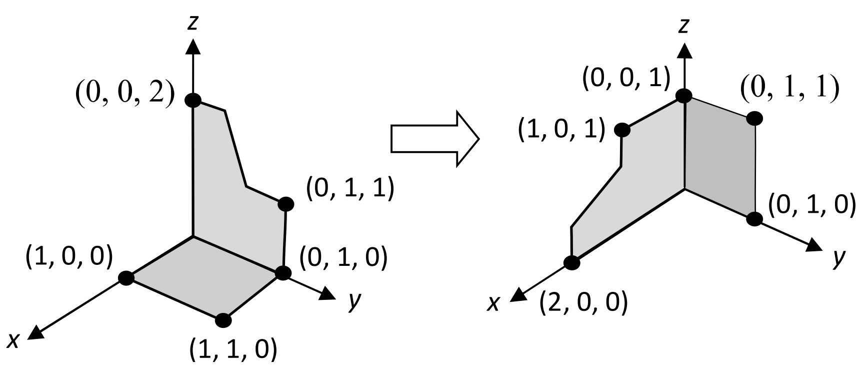
Assignment

Give answers to the followings questions and submit your work in pdf, or as a scanned copy of your work. State clearly your steps in the calculations.

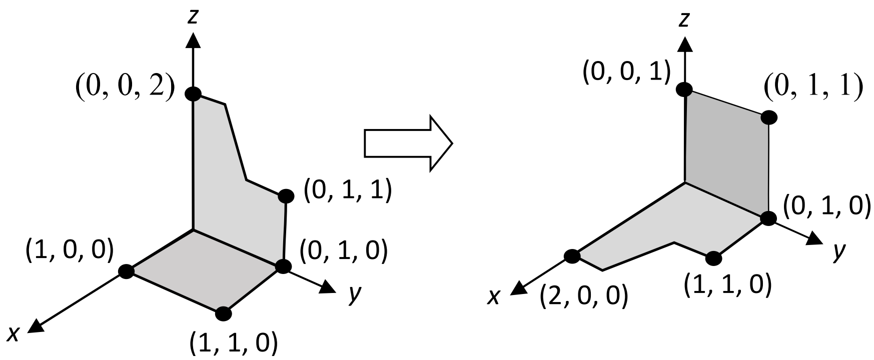
Submission deadline: 9 Dec 2019

1. A graphics workstation supporting a resolution of 1024x768 is capable of displaying 512 colours simultaneously.
   (a) State the total number of bit planes used, and the number of bit planes for each primary colour. (6 marks)
   (b) State the total memory (in bytes) required for the frame buffer. (2 marks)
   (c) If an 8-bit wide lookup table is used for each primary colour, state the total number of choices of colours available. (4 marks)

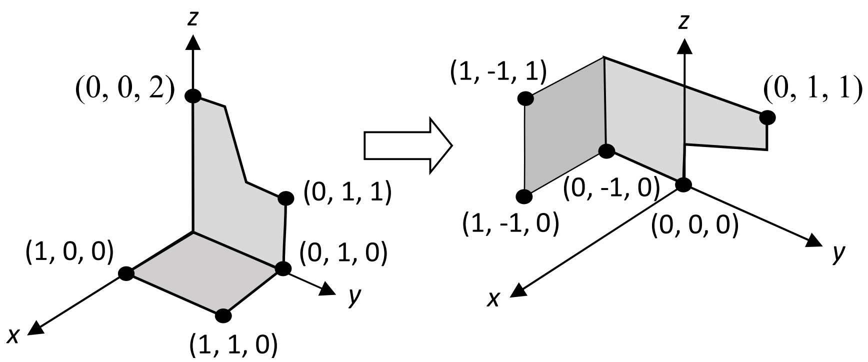
2. State a transformation matrix for each of the following transforms.
   (a) (6 marks)



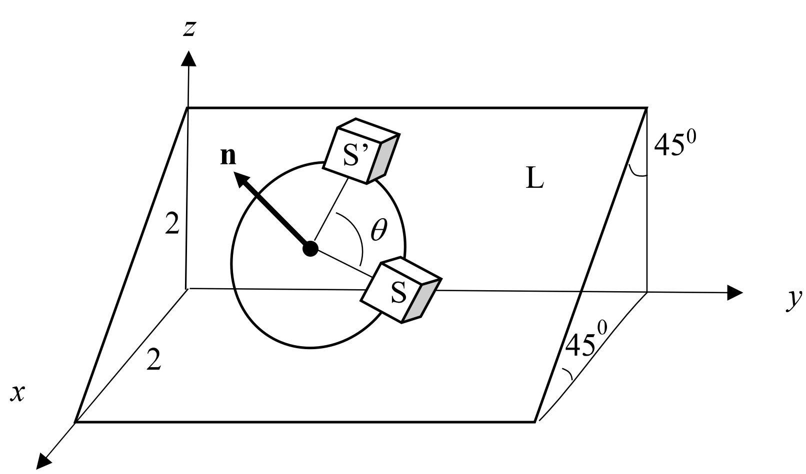
   (b) (6 marks)



(c) (6 marks)



3. An object S lying on a plane L is to be rotated 90^0 to S' such that it lies on the circumference of a circle centered at (1, 1, 1) lying on L as shown below. This is performed with a list of basic transforms (i.e. translations and rotations about the x, y and z axes). State the vector **n** normal to L and the sequence of transformations required, and the transformation matrices for each of the transforms. (15 marks)



4. A parametric cubic curve $\mathbf{p}(t)$, $0 \le t \le 1$, is defined with the end points $\mathbf{p}_0 = [-1, 0, 0, 1]$, $\mathbf{p}_1 = [0, 1, 0, 1]$, and end point tangents $\mathbf{p}_0' = [0, 1, 0, 0]$, $\mathbf{p}_1' = [1, 0, 0, 0]$. A Bezier curve $\mathbf{b}(s)$, $0 \le s \le 1$, is constructed with control points $\mathbf{b}_0$, $\mathbf{b}_1$, $\mathbf{b}_2$, $\mathbf{b}_3$ such that $\mathbf{p}_1 = \mathbf{b}_0$.
   (a) Determine the curve point $\mathbf{p}(0.5)$. (6 marks)
   (b) Determine the location of $\mathbf{b}_1$ if $\mathbf{p}(t)$ and $\mathbf{b}(s)$ are connected with C^1 continuity. (4 marks)

5. An order 3 open uniform B-spline curve $\mathbf{p}(t)$ is constructed with the control points $\mathbf{p}_0 = (-2, 0, 0)$, $\mathbf{p}_1 = (-1, 1, 0)$, $\mathbf{p}_2 = (0, 0, 0)$, $\mathbf{p}_3 = (1, -1, 0)$, $\mathbf{p}_4 = (2, 0, 0)$.
   (a) State the knot vector for the curve. (2 marks)
   (b) State the parametric range of the curve segments composing the B-spline curve. (3 marks)
   (c) Determine the Blending functions $N_{0,3}(t)$, $N_{1,3}(t)$, $N_{2,3}(t)$, $N_{3,3}(t)$, $N_{4,3}(t)$ for the first segment. (8 marks)
   (d) Sketch the shape of $\mathbf{p}(t)$. (3 marks)
   (e) If $\mathbf{p}_2$ is moved to $(-1, 1, 0)$, sketch the shape of $\mathbf{p}(t)$. (3 marks)

6. A sweep surface $\mathbf{s}(u, v)$, $0 \le u, v \le 1$, is created by transforming a Bezier curve $\mathbf{p}(u)$ defined with the control points $\mathbf{b}_0 = (-1, 0, 0)$, $\mathbf{b}_1 = (0, 1, 0)$, and $\mathbf{b}_2 = (1, 0, 0)$ along the z-axis for a distance of 10 unit while rotating $\mathbf{p}(u)$ about the z-axis for an angle π.
   (a) State in terms of $\mathbf{b}_0$, $\mathbf{b}_1$, $\mathbf{b}_2$ an expression for $\mathbf{p}(u)$. (2 marks)
   (b) State the sweep transformation matrix required. (3 marks)
   (c) Determine the surface point $\mathbf{s}(0.5, 0.5)$. (5 marks)

7. A ruled surface $\mathbf{s}(u, v)$, $0 \le u, v \le 1$, is constructed between a Bezier curve $\mathbf{b}(u)$ and a straight line $\mathbf{p}(u)$. The Bezier curve is constructed with the control points $\mathbf{b}_0$, $\mathbf{b}_1$, $\mathbf{b}_2$, and the straight line is defined with the points $\mathbf{p}_0$, $\mathbf{p}_1$. Derive expressions in terms of $\mathbf{b}_0$, $\mathbf{b}_1$, $\mathbf{b}_2$, $\mathbf{p}_0$, and $\mathbf{p}_1$ for the following:

   (a) the ruled surface $\mathbf{s}(u, v)$. (4 marks)
   (b) the iso-u tangent of $\mathbf{s}(u, v)$ at $u = 0.5$, $v = 0.5$. (4 marks)
   (c) the iso-v tangent of $\mathbf{s}(u, v)$ at $u = 0.5$, $v = 0.5$. (4 marks)
   (d) the twist vector of $\mathbf{s}(u, v)$ at $u = 0.5$, $v = 0.5$. (4 marks)

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