[redacted]

Computer-Aided Design and Manufacturing

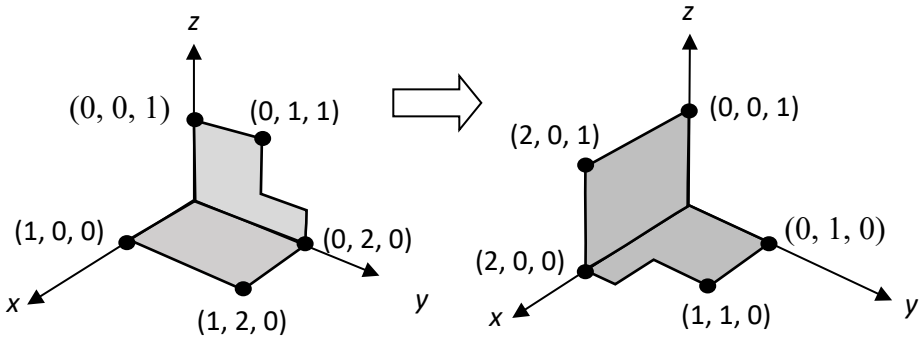
Assignment

Give answers to the followings questions and submit your work in a single pdf file. Make sure the file is easy to read with a white background (Do not submit photos). State clearly your steps in the calculations.

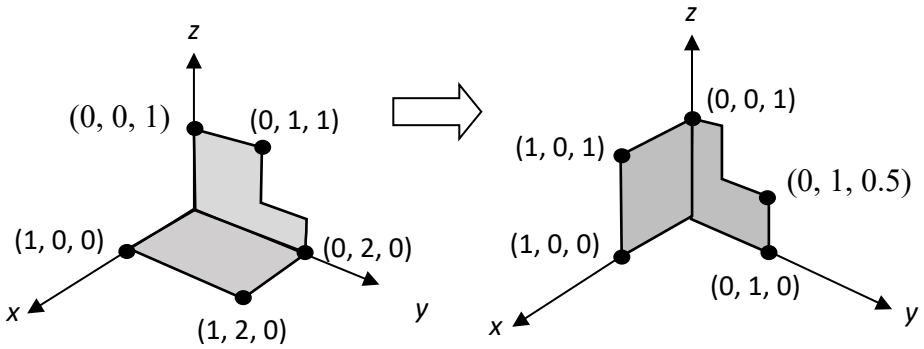
Submission deadline: 23 Dec 2021

1. A graphics system with a resolution of 1024x768 supports a total of 32768 colors simultaneously.
   (a) State the total number of bit planes of the system and the number of bit planes for each primary color. (5 marks)
   (b) State the total memory (in bytes) required for the frame buffer. (2 marks)
   (c) If a 8-bit wide lookup table is used for each primary color, state the total number of choices of colors available. (4 marks)

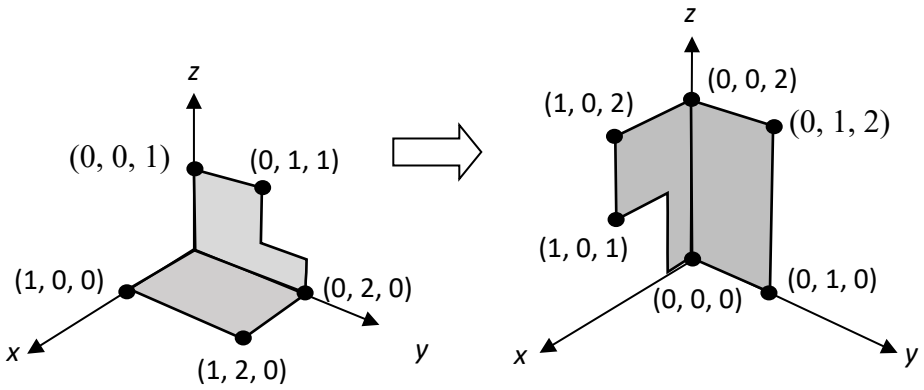
2. State a transformation matrix for each of the following transforms.
   (a) (6 marks)



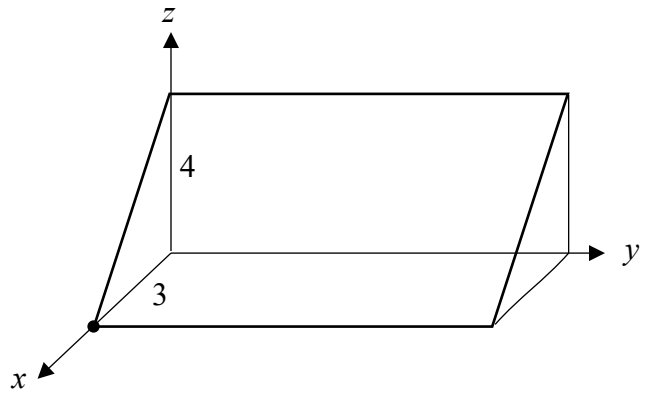
   (b) (6 marks)



(c) (8 marks)

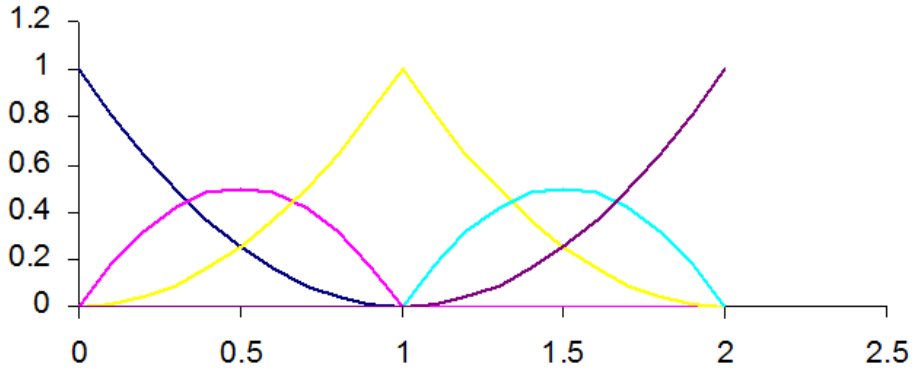


3. An object is to be reflected about a plane passing through the point (3, 0, 0) as shown in the figure below. The reflection transform is obtained with a series of basic transforms. State the series of transformations required and the transformation matrix for each of these basic transforms. (12 marks)



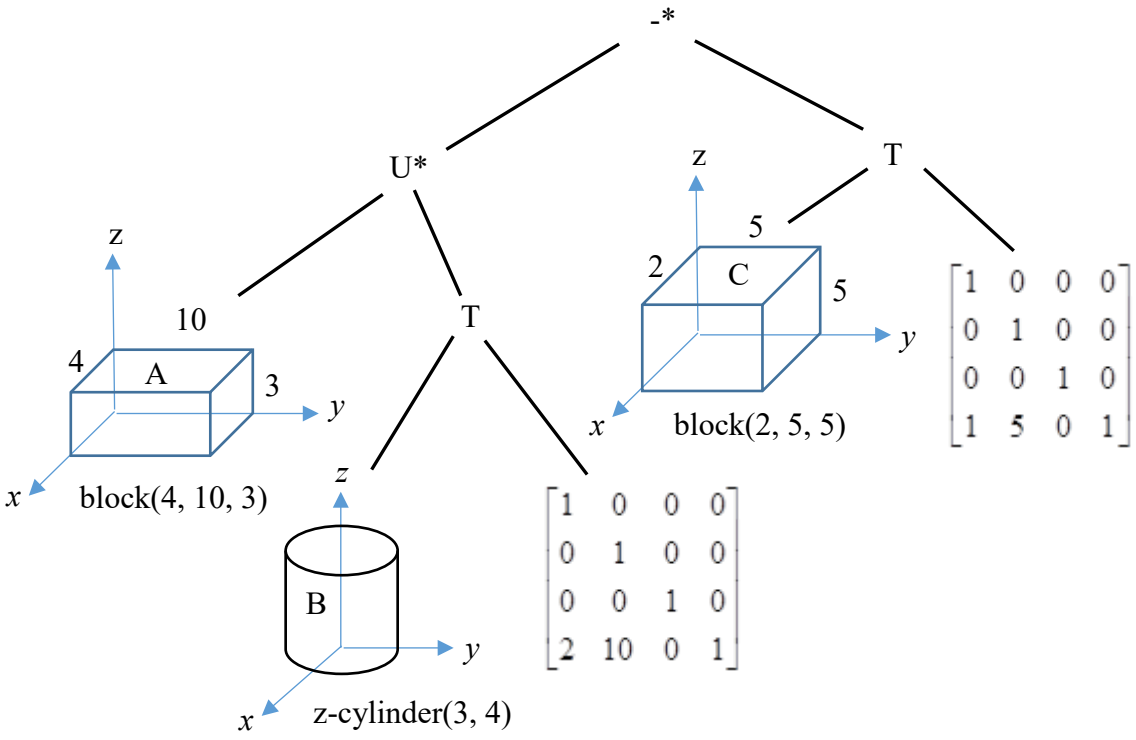
4. A spline curve $\mathbf{p}(u)$, $0 \le u \le 1$, with two parametric cubic curve segments $\mathbf{p}_a(t)$, $\mathbf{p}_b(t)$, $0 \le t \le 1$, are to be constructed through the points $\mathbf{p}_0 = [0\ 0\ 0\ 1]$, $\mathbf{p}_1 = [1\ 0\ 0\ 1]$, and $\mathbf{p}_2 = [2\ 0\ 0\ 1]$ such that $\mathbf{p}_a(t)$ passes through $\mathbf{p}_0$ and $\mathbf{p}_1$, whereas $\mathbf{p}_b(t)$ passes through $\mathbf{p}_1$ and $\mathbf{p}_2$. The curve tangents at $\mathbf{p}_0$ and $\mathbf{p}_2$ are $\mathbf{p}_0' = [0\ 1\ 0\ 0]$, and $\mathbf{p}_2' = [0\ 1\ 0\ 0]$, and $\mathbf{p}_a(t)$ and $\mathbf{p}_b(t)$ are C^2 continuous at $\mathbf{p}_1$. A ruled surface $\mathbf{s}(u, v)$, $0 \le u, v \le 1$, is constructed between $\mathbf{p}(u)$ and a straight line $\mathbf{q}(u)$ defined between $\mathbf{q}_0 = [0\ 0\ 5\ 1]$ and $\mathbf{q}_1 = [0\ 5\ 5\ 1]$.
   (a) Determine the curve tangent of the curve $\mathbf{p}(u)$ at $\mathbf{p}_1$. (6 marks)
   (b) State a function relating t and u for the curve $\mathbf{p}_a(t)$. (2 marks)
   (c) Determine the surface point $\mathbf{s}(0.25, 0.5)$. (12 marks)

5. Consider a 3rd order B-spline curve $\mathbf{p}(t)$ with control vertices $\mathbf{b}_0 = (0, 0, 0)$, $\mathbf{b}_1 = (1, 1, 0)$, $\mathbf{b}_2 = (2, 1, 0)$, $\mathbf{b}_3 = (3, 0, 0)$, $\mathbf{b}_4 = (4, 1, 0)$ and basis functions as shown below.

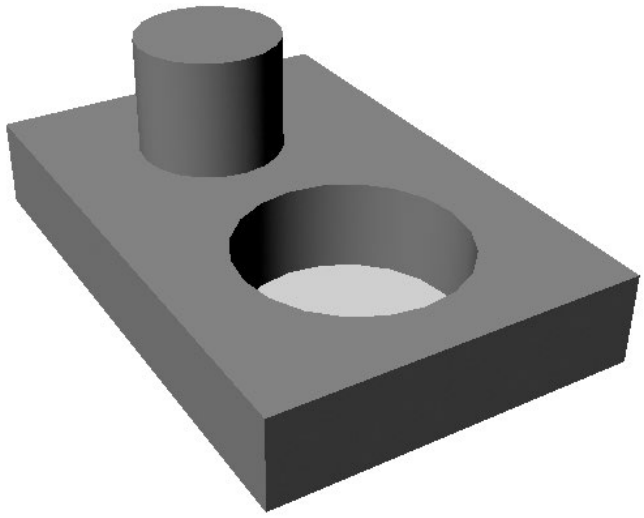


(a) State the knot vector of the curve. (3 marks)
(b) State the parametric range for each curve segments of the curve. (2 marks)
(c) Sketch the control polygon and the shape of the curve. (3 marks)
(d) Determine the blending functions for $\mathbf{p}(t)$, $1 \le t \le 2$. (10 marks)
(e) Determine the curve point at $\mathbf{p}(1.5)$. (5 marks)

6. Given the CSG representation of an object S as shown below. Classify the point $\mathbf{p} = (2, 8, 3)$ with respect to S. List the steps involved. (9 marks)



7. Boundary representation is used to model an object as shown below. Use the Euler Poincare formula to verify if the object is a valid solid. Modify the B-Rep if necessary. Illustrate with a sketch if the B-Rep is modified. (5 marks)



******** End ********