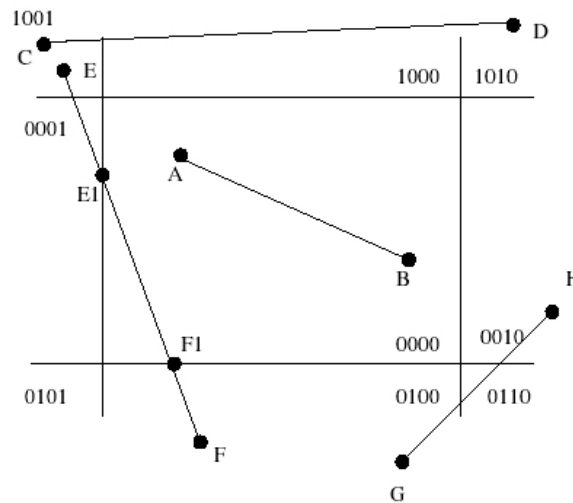


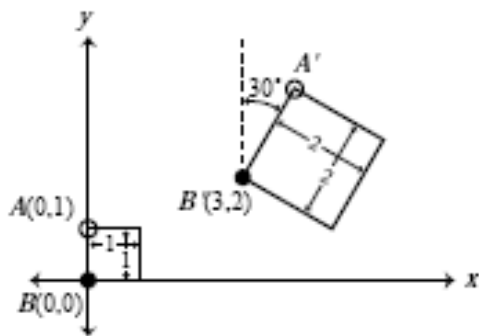
- Q1. Consider the vectors  $v = (3; 1)$  and  $w = (0; 2)$ . Calculate  $v-w$  and  $v+w$ ?
- Q2. Consider the vectors  $u = (1; 1; 0)$ ,  $v = (0; 2; 3)$  and  $w = (2; 4; 3)$ , using dot product, find which vectors are parallel?
- Q3. Find the angle between  $(1; 2; 3)$  and  $(0, 1, 4)$ ?
- Q4. Are the vectors  $u = (1; 2; 3)$ ;  $v = (3, 0, -1)$  perpendicular?
- Q5. Is the angle between  $u = (2; 4; 0)$  and  $v = (3; 0; -1)$  greater or smaller than  $90^\circ$ ?
- Q6. Let  $p = (1; 3; 4)$  and  $q = (5; 2; 7)$  be two vectors. Calculate  $(p \times q)$  and  $(p \cdot q)$ ?
- Q7. Let  $v = (0; 1; 2)$  and  $w = (3; 0; 4)$ . Find the projection of  $v$  onto  $w$ ?
- Q8. Find the polar coordinates for the point  $(3; -4)$ ?
- Q9. Given the polar coordinates  $r = 2$  and  $\theta = 3\pi/4$ , find the corresponding Cartesian coordinates?
- Q10. Given a point  $P = (2, 3, 1)$ , a vector  $V = (-2, 1, 4)$  and suppose  $Q(t) = P + Vt$ , answer the following
- What does  $Q$  represent, and what is  $Q(t)$ ?
  - Determine a vector  $W$  that is perpendicular to  $V$  and the  $z$ -axis.
- Q11. Describe an algorithm for clipping a line against a rectangle?
- Q12. Find the lines clipping result for the rectangle bounded by  $(2,2)-(15, 20)$ , for the lines  $(10,12)-(20, 8)$  and  $(3,4)-(1, 17)$ ?
- Q13. Clip the polygon bounded by the points  $(4,7),(5, 10),(10, 7),(8, 1), (5, -1)$  against the window  $(3,3)-(10,10)$ ?
- Q14. Define computer graphic transformation? What are the basic transformations?
- Q15. Why do we need transformation in computer graphics?
- Q16. Drive the formula for applying translation to an object with reference point  $(x_1, y_1)$  to  $(x_2, y_2)$  and rotate it by  $\theta$  angle?
- Q17. Explain why do we present 2D transformation with  $3 \times 3$  matrix instead of  $2 \times 2$ ?
- Q18. Find the transformation matrix of an object with reference point  $(2,10)$  after translation to  $(8, 5)$  sharing in  $x$  by  $30$  degree and rotating by  $45$  degree CCW?
- Q19. Prove that if
- Q20. Give the formula for a Bezier cubic curve. Derive the conditions necessary for two Bezier cubic curves to join with (i) just  $C_0$ -continuity and (ii)  $C_1$ -continuity?
- Q21. Calculate the composite rotation matrix for a rotation over  $90$  degrees ( $\pi/2$  radians) around the  $x$ -axis followed by a rotation over  $90$  degrees over the (global)  $z$ -axis?

Q22. Cohen-Sutherland xy outcodes have 4 bits. This suggests  $2^4 = 16$  codes. Yet only 9 codes are used? What happened to the other 7 ?

Q23. Using bitwise operation finds if the following lines are completely in, partially in or completely out?



Q24. Find the transformation matrix for the shape at the origin?



Q25. What is the difference between linear transformation and affine transformation? Give an example of it.

Q26. Show that if  $AB=BA$  is commutative operation then successive translation is Commutative?

Q27. Show that if  $AB=BA$  is commutative operation then successive scaling is Commutative?

Q28. Show that if  $AB=BA$  is commutative operation then successive rotation is not Commutative?

Q29. Is  $RT=TR$  according to commutative law? Show that with example.

Q30. Is  $SR=RS$  according to commutative law? Show that with example.

Q31. We say that two matrices A and B commute if  $A B = B A$ . Matrices do not commute in general, but certain types of matrices do. Which of the following types of matrices commute? Assume matrices are  $4 \times 4$ .

- a. scaling matrices  $S_1 S_2$
- b. translation matrices  $T_1 T_2$
- c. rotation matrices,  $R_1 R_2$
- d. rotation and translation,  $RT$
- e. scaling and translation,  $ST$
- f. scaling and rotation,  $SR$

- Q32. Write the following as a sequence of 4 x 4 matrices. Scale the object by a factor 3 in the y direction, while leaving the position of the point  $(x, y, z) = (4, -1, 1)$  unchanged in the object?
- Q33. Let the camera be at  $(3; 4; 3)$  in world coordinates. Let the z axis of the camera be in direction  $(1, -2, 1)$ . Let the  $V_{up}$  be  $(1, -2, 0)$ . Give a transformation that maps world coordinates to camera coordinates?
- Q34. Map the line  $(2,6)-(7, 10)$  from the world coordinate bounded by  $(2,2)-(10,10)$  to the view coordinate window of  $(4,4)-(15,12)$ ?
- Q35. Suppose that a shiny ground plane  $y = 0$  is illuminated by sunlight. Let the direction of the sun be  $(1; 2; 2)$ . If a viewer is at  $(x; y; z) = (4; 6; 7)$ , determine the position on the ground plane at which the peak of the highlight occurs. Assume that the peak occurs where a mirror reflection takes a ray from the source and reflects it directly to the viewer position.
- Q36. Suppose that a shiny plane,  $2x+y + 2z + 17 = 0$ ; is illuminated by sunlight. Let the direction of the sun be  $l = (0; 1; 0)$ . Assuming the viewer is at the origin,  $(x; y; z) = (0; 0; 0)$ , determine the position on this shiny plane at which the peak of the highlight occurs.
- Q37. Consider a 3D triangle that is defined by vertices:

$$P1=(-5,2,-7), P2=(-6, 4, -8), P3=(-7, 3, -3)$$

and suppose that we project this triangle onto the  $z=-2$  plane, using perspective projection with the center of projection at the origin. We also texture map this triangle, and choose texture coordinates such that

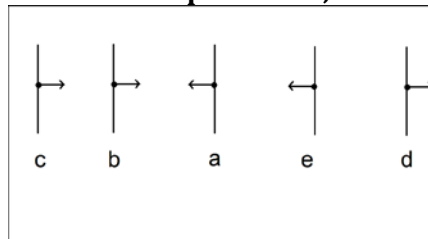
$$(s; t) = (0; 0) \rightarrow P1$$

$$(s; t) = (1; 0) \rightarrow P2$$

$$(s; t) = (0; 1) \rightarrow P3$$

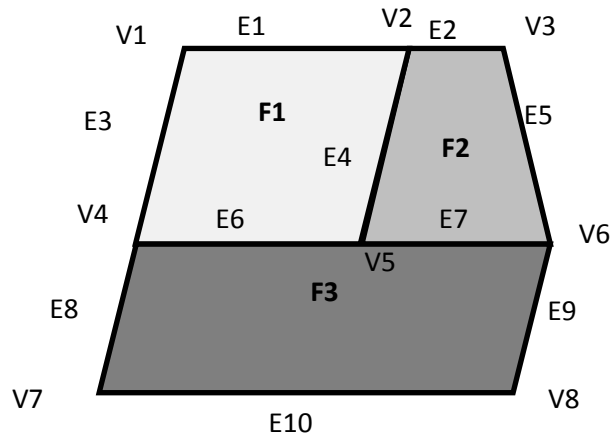
Give the homography that corresponds to the mapping from  $(s; t)$  to the projection plane coordinates  $(x; y)$ ?

- Q38. Consider a 2D space  $(x; y)$  whose points are represented using homogeneous coordinates. Give a product of matrices that performs the following. Mapping a rectangle having opposite corners  $(1, -2)$  and  $(3, 3)$  to a rectangle having opposite corners  $(2, 0)$  and  $(10, 12)$ ?
- Q39. Construct a BSP tree for a 2D scene below. For each subtree, choose the edge from the list in alphabetical order. In particular, the root of the tree is edge a.

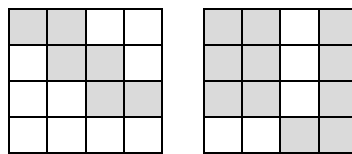


- Q40. What is the order of edges drawn for a viewer that is located between edges a and b for Q39 above?
- Q41. Describe the different coordinate systems used for texture mapping.
- Q42. Describe how texture coordinates are computed during scan conversion with a sweep-line algorithm.
- Q43. Describe at least three different lighting parameters that could be modulated with texture maps. For each, give an example object for which the texture map would be useful.

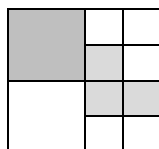
- Q44. What are Mip Maps? Give an example of when they are useful. Why are they used?
- Q45. What is bump mapping? Give an example object that might use it. Write a procedure that describes a plausible bump map for that object.
- Q46. What is environment mapping? When is it used? How could an environment map be captured?
- Q47. Can we obtain a reflection about the y or x axis using rotation of 180 degree? Explain your answer.
- Q48. Using winged edged algorithm find the vertex, edge and face tables for the following polygons?



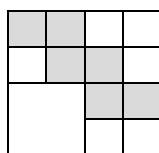
- Q49. Determine the union and cross operation result for the following voxel representations?



- Q50. Find the quad tree representation for the following representations:

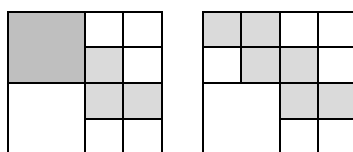


a.

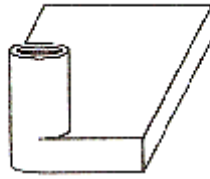


b.

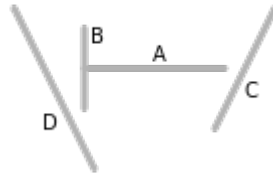
- Q51. Determine the union and cross operation result for the following quad representations?



- Q52. From the basic 3D shapes, find the constructive solid geometry tree for the following shape?



Q53. Find the BSP tree for the following shape?



Q54. Find the transformation matrix for scaling a 3D shape by 2 in x-axis, 0.5 in y-axis and 1.5 in z-axis and rotating it around the line bounded by the points (4,4,4)-(10,10,10)?

Q55. If the view reference point is at (2,-3,5) and the view plane normal vector is (3,5,5) and the view up vector is (5,7,7), find the world to view coordinate matrix R.T for this plane?

Q56. How many types of projections are there? Explain the difference between them.

Q57. Explain with examples the difference between orthographical and oblique projections?

Q58. If a 3D object have a point (10, 13, 10), find the parallel projection matrix if the viewer is at (5, 25, -15) and the viewing plane is the xy-plane?

Q59. If the prospective plane is at  $z=1$  and bounded by the lines  $y=2$  and  $y=10$  and the viewing point is at (10, 5, 10). Find if the point (5, -2, -5) have a projection on the plane or not?

Q60. If the light source is at point (2, 5, 9) and the object reference point is (10, 8, 0). The maximum light intensity is 15 at the direction (6,7,5). Find the light source intensity if the attenuation factors are ( $k_c=0.7$ ,  $k_l=0.5$ ,  $k_q=1.0$ )?

Q61. It is not possible to ideally measure irradiant energy for "all" situations. Why?

Q62. What are the simple mathematical representations of light sources?

Q63. What are the basic reflectance models proposed by phong in illumination?

Q64. If the light source is at (-5, -5, -5) with intensity 10. Calculate the diffuse light intensity at (20, 8, 15) which belong to the surface containing the points (10, 8, 10) and (7, 8, 20) with diffuse factor of 0.25?

Q65. If the light source is at (-5, -5, -5) with intensity 10. Calculate the specular light intensity at the viewer (20, 8, 15) if the reflective surface containing the point (10, 8, 10) and have the normal (3, 5, 6), knowing that the reflection factor is 0.25 and  $n=3$ ?

Q66. The viewer stands at the point (2, 2, 2) looking at a mirror surface having the points (20, 18, 25), (25, 17, 14), (12, 13, 20). If a light source with intensity 20 located at (40, 3, 35) is directed at this surface, find the total light intensity effecting the viewer knowing that the ambient light intensity is 5 and the surface ambient, specular and diffuse reflecting factors are 0.3, 0.1 and 0.15 respectively?

Q67. If a 3D object have a reference point (4, -5, 10), find the final transformation matrix when the object is scaled by 2, .4 and .6 in the x, y, z directions and rotated 180 degree around the x-axis?

Q68. True or false, rotation around the y-axis in 3D is the same as the standard rotation in 2D?

Q69. Prove that  $R(\theta_1)R(\theta_2)=R(\theta_1+\theta_2)$ ?

Q70. Prove that  $S(x/2, y/2)S(2x, 2y)=S(x, y)$ ?

Q71. Prove that  $R(180)R(\theta)=R(-\theta)$ ?

Q72. Is  $R(\theta_1)R(\theta_2)=R(\theta_2)R(\theta_1)$ ? Explain with example.

Q73. If a square Bezier curve have the three control points (2,3), (7, 17) and (12, 5), find the next three points in the next curve assuming we have a C2 continuity condition?

Q74. If the basic Bezier line equation is given by

$$B_L=(1-u^2)*P_1+u^2*P_2$$

Drive the new Cubic Bezier curve based on this equation?

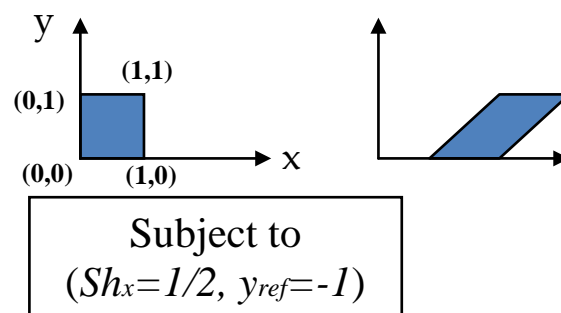
Q75. What are the differences between curve continuity effects on curve connection in Bezier curve? Explain with example.

Q76. Draw the 3D rendering pipeline and briefly explain each step of it?

Q77. Draw the 2D rendering pipeline and briefly explain each step of it?

Q78. In 2D viewing transformation, does the view window ratio has an effect on the final generated shapes? Explain with example.

Q79. For the following shape, find the transformation matrix per the given values?



Q80. Give an application example where the following 3D modelling is used?

- Voxel.
- Constructive solid geometry.