

# CompSci 372 S1 C 2007

## Computer Graphics

Mid Term Test – Thursday, 3<sup>rd</sup> May 2007, 6.30 pm – 7.30 pm

VERSION CODE 00000020

### Instructions:

1. Attempt **ALL** questions.
2. Fill in the appropriate boxes in the answer sheet using a **pencil**. There is only one correct answer for each question.
3. If you want to change your answer **erase the previously filled in box completely** using an eraser.
4. The test is for one (1) hour.
5. This is a **closed book** test.
6. Calculators and electronic devices are **NOT** permitted.
7. **Questions total 50 Marks**. Each question is worth 2 marks.
8. This test is worth 10% of your final marks for CompSci372 S1 C

### Answers:

- |      |    |      |    |
|------|----|------|----|
| Q1:  | c) | Q16: | a) |
| Q2:  | d) | Q17: | c) |
| Q3:  | b) | Q18: | b) |
| Q4:  | d) | Q19: | a) |
| Q5:  | c) | Q20: | d) |
| Q6:  | d) | Q21: | a) |
| Q7:  | a) | Q22: | c) |
| Q8:  | b) | Q23: | a) |
| Q9:  | a) | Q24: | b) |
| Q10: | b) | Q25: | d) |
| Q11: | a) |      |    |
| Q12: | d) |      |    |
| Q13: | c) |      |    |
| Q14: | b) |      |    |
| Q15: | c) |      |    |
- Blender
- 9
- $(M^{-1})^T$

### Question 1:

Vertex operations in the Graphics pipeline are executed in the following order:

- (a) Illumination → MODELVIEW transformations → PROJECTION transformations → Clipping
- (b) Illumination → MODELVIEW transformations → Clipping → PROJECTION transformations
- (c) MODELVIEW transformations → Illumination → PROJECTION transformations → Clipping
- (d) None of the above

### Question 2:

The programme you used in assignment 1 to create a 3D model of the initials of your name is called:

- (a) 3D Studio Max
- (b) Maya
- (c) Autocad
- (d) None of the above

### Question 3:

Which of the following statements is **false**?

- (a) Physically-based animations reduce the need for human animators
- (b) Physically-based animations are computationally easy to solve
- (c) Physically-based animations can be reused in different applications
- (d) Physically-based animations involve solving differential equations

### Question 4:

Given are two orthogonal vectors **a** and **b** with length 3. Then  $|\mathbf{a} \times \mathbf{b}|$  equals

- (a) 0
- (b) 3
- (c) 6
- (d) None of the above

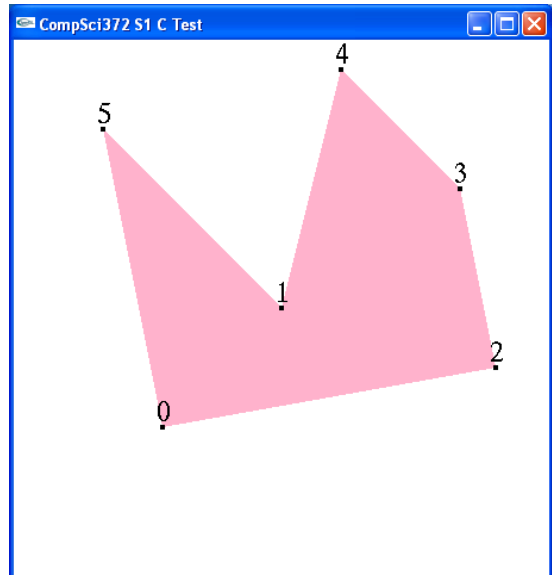
### Question 5:

Given are the vertices

```
const int numVertices=6;
const float vertices[numVertices][2] =
    {{100,100},{200,200},{380,150},
     {350,300},{250,400},{50,350}};
```

In which sequence do we have to call these vertices (using `glVertex2fv`) in order to draw the shape on the right using the OpenGL commands `glBegin(GL_TRIANGLE_FAN)` and `glEnd()`.

- (a) 5, 0, 2, 3, 4, 1
- (b) 5, 0, 1, 2, 3, 4
- (c) 1, 5, 0, 2, 3, 4
- (d) 0, 2, 3, 4, 1, 5



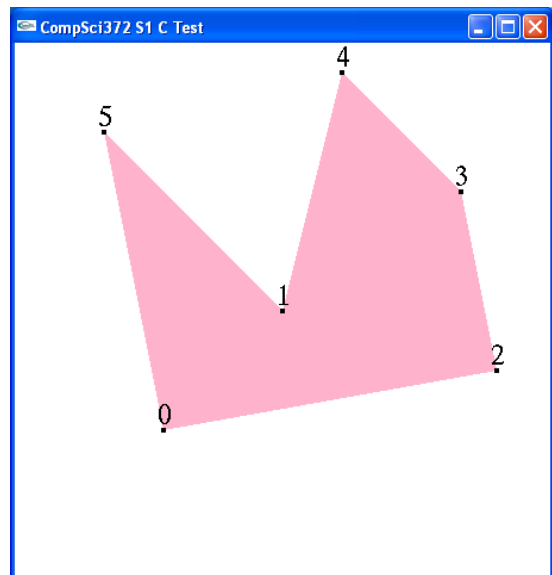
### Question 6:

Given are the vertices

```
const int numVertices=6;
const float vertices[numVertices][2] =
    {{100,100},{200,200},{380,150},
     {350,300},{250,400},{50,350}};
```

In which sequence do we have to call these vertices (using `glVertex2fv`) in order to draw the shape on the right using the OpenGL commands `glBegin(GL_TRIANGLE_STRIP)` and `glEnd()`.

- (a) 5, 0, 2, 3, 4, 1
- (b) 5, 0, 1, 2, 3, 4
- (c) 1, 5, 0, 2, 3, 4
- (d) 3, 4, 2, 1, 0, 5



### Question 7:

What is the **minimum** number of vertices required to draw a shape with 3 triangles using the OpenGL commands `glBegin(GL_TRIANGLE_STRIP)` and `glEnd()`? Note that this question refers to the optimal case, where the triangles share edges appropriately.

- (a) 5
- (b) 7
- (c) 9
- (d) None of the above

**Question 8:**

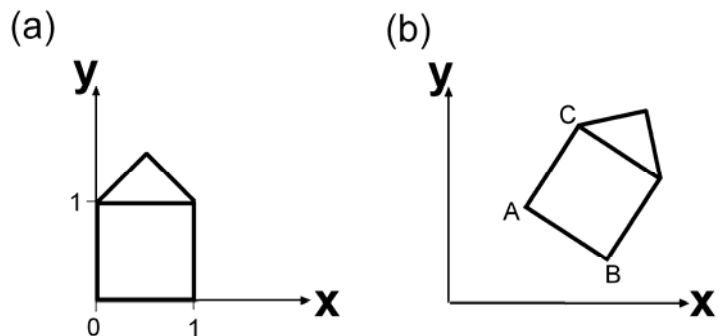
The model view matrix  $\begin{pmatrix} \cos \varphi & -\sin \varphi & 0 & 2 \\ \sin \varphi & \cos \varphi & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$  is created by using the OpenGL commands

- (a) `glMatrixMode(GL_MODELVIEW);`  
`glLoadIdentity();`  
`glRotatef( $\varphi$ , 0, 0, 1);`  
`glTranslatef(2, 0, 0);`
- (b) `glMatrixMode(GL_MODELVIEW);`  
`glLoadIdentity();`  
`glTranslatef(2, 0, 0);`  
`glRotatef( $\varphi$ , 0, 0, 1);`
- (c) `glMatrixMode(GL_MODELVIEW);`  
`glLoadIdentity();`  
`glRotatef( $\varphi$ , 1, 0, 0);`  
`glTranslatef(2, 0, 0);`
- (d) None of the above

**Question 9:**

The 2D scene in part (a) of the image on the right is transformed into the scene in part (b) by using a homogeneous 2D transformation matrix  $\mathbf{M}$ .

The dimensions of the house do not change during the transformation and the new coordinates of its corners are



$$A = \begin{pmatrix} a_x \\ a_y \end{pmatrix}, B = \begin{pmatrix} b_x \\ b_y \end{pmatrix}, \text{ and } C = \begin{pmatrix} c_x \\ c_y \end{pmatrix}.$$

The matrix  $\mathbf{M}$  performing this transformation is

(a) 
$$M = \begin{pmatrix} 1 & 0 & a_x \\ 0 & 1 & a_y \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} b_x - a_x & c_x - a_x & 0 \\ b_y - a_y & c_y - a_y & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

(b) 
$$M = \begin{pmatrix} b_x - a_x & c_x - a_x & 0 \\ b_y - a_y & c_y - a_y & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 & a_x \\ 0 & 1 & a_y \\ 0 & 0 & 1 \end{pmatrix}$$

(c) 
$$M = \begin{pmatrix} b_y - a_y & c_y - a_y & 0 \\ b_x - a_x & c_x - a_x & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 & a_x \\ 0 & 1 & a_y \\ 0 & 0 & 1 \end{pmatrix}$$

- (d) None of the above

**Question 10:**

What is the homogeneous matrix for reflecting a 2D point on the line  $y = -x$  (i.e. the line which consists of all points  $(k, -k)$ ,  $k \in \Re$ ) ?

$$(a) \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$(b) \begin{pmatrix} 0 & -1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$(c) \begin{pmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

(d) None of the above

**Question 11:**

Given is an implicit surface defined by the equation  $3e^x + y^2 \cos z - xyz = 0$ . The normal of this surface at the point  $(x, y, z)$  is given by

$$(a) \begin{pmatrix} 3e^x - yz \\ 2y \cos z - xz \\ -y^2 \sin z - xy \end{pmatrix}$$

$$(b) \begin{pmatrix} 3e^x - y^2 \cos z - yz \\ 2y \cos z - xz \\ y^2 \sin z - xy \end{pmatrix}$$

$$(c) \begin{pmatrix} 3e^x - yz \\ 2y \cos z - xz \\ y^2 \sin z - xy \end{pmatrix}$$

(d) None of the above

**Question 12:**

Which of the following line segments intersects the plane  $\begin{pmatrix} 3 \\ 1 \\ 2 \end{pmatrix} \cdot \mathbf{p} = 5$  ?

$$(a) \text{ The line segment from } \begin{pmatrix} 1 \\ 0 \\ 2 \end{pmatrix} \text{ to } \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}.$$

$$(b) \text{ The line segment from } \begin{pmatrix} 1 \\ 0 \\ -1 \end{pmatrix} \text{ to } \begin{pmatrix} -1 \\ 0 \\ 2 \end{pmatrix}.$$

$$(c) \text{ The line segment from } \begin{pmatrix} 0 \\ -1 \\ 1 \end{pmatrix} \text{ to } \begin{pmatrix} -1 \\ 4 \\ 0 \end{pmatrix}$$

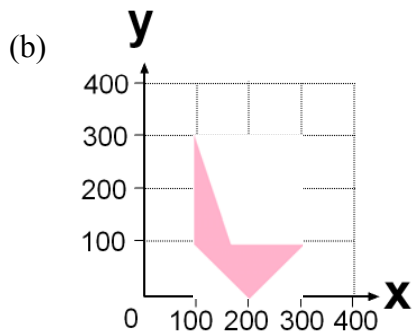
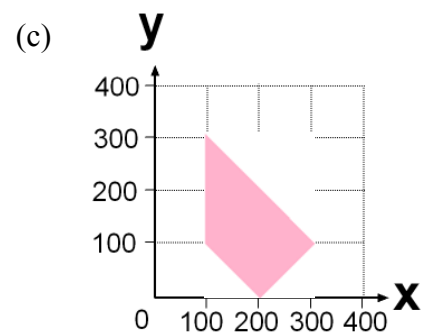
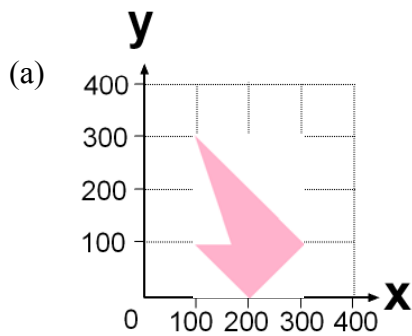
(d) None of the above

**Question 13:**

Given is an OpenGL program with the display method

```
void display(void)
{
    // clear all pixels in frame buffer
    glClear(GL_COLOR_BUFFER_BIT);
    glColor3f(0.0, 0.0, 0.0);
    glBegin(GL_TRIANGLE_FAN);
    glVertex2f(300, 100);
    glVertex2f(100, 300);
    glVertex2f(100, 100);
    glVertex2f(200, 0);
    glEnd();
    glFlush();
}
```

What shape does this display method draw?



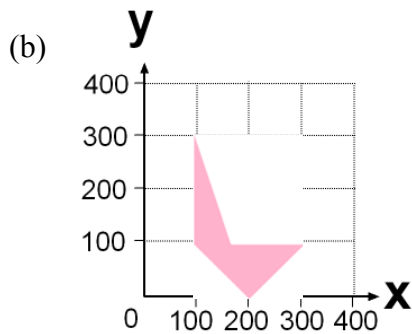
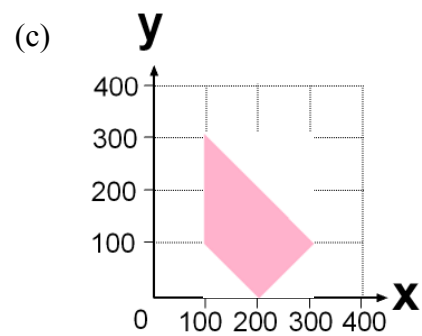
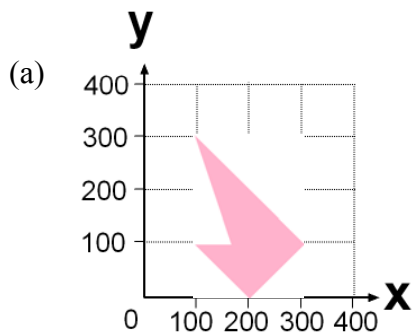
(d) None of the above

**Question 14:**

Given is an OpenGL program with the display method

```
void display(void)
{
    // clear all pixels in frame buffer
    glClear(GL_COLOR_BUFFER_BIT);
    glColor3f(0.0, 0.0, 0.0);
    glBegin(GL_TRIANGLE_STRIP);
    glVertex2f(300, 100);
    glVertex2f(200, 0);
    glVertex2f(100, 100);
    glVertex2f(100, 300);
    glEnd();
    glFlush();
}
```

What shape does this display method draw?



(d) None of the above

**Question 15:**

The dot product of  $\mathbf{u} = \begin{pmatrix} -1 \\ -2 \\ 3 \end{pmatrix}$  and  $\mathbf{v} = \begin{pmatrix} 0 \\ 3 \\ 4 \end{pmatrix}$  equals

- (a) -16
- (b) -6
- (c) 6
- (d) None of the above

**Question 16:**

The vector product of  $\mathbf{u} = \begin{pmatrix} -1 \\ -2 \\ 3 \end{pmatrix}$  and  $\mathbf{v} = \begin{pmatrix} 0 \\ 3 \\ 4 \end{pmatrix}$  equals

(a)  $\begin{pmatrix} -17 \\ 4 \\ -3 \end{pmatrix}$

(b)  $\begin{pmatrix} 0 \\ -6 \\ 12 \end{pmatrix}$

(c)  $\begin{pmatrix} 0 \\ 1 \\ 7 \end{pmatrix}$

- (d) None of the above

**Question 17:**

In OpenGL, visible surface determination (otherwise known as hidden surface removal) is achieved by use of a

- (a) Sorting algorithm
- (b) Cyrus-beck clipping algorithms
- (c) Depth buffer
- (d) None of the above

**Question 18:**

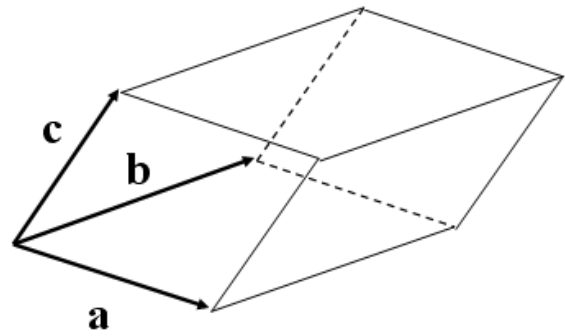
The area of a parallelogram can be computed from two adjacent edge vectors as

- (a) the absolute value of their dot product
- (b) the length of their cross product
- (c) the product of their lengths
- (d) None of the above



**Question 19:**

Give is a parallelepiped, i.e. a cuboid which has been sheared such that opposite faces remain parallel. The parallelepiped is defined by the three vectors  $\mathbf{a}$ ,  $\mathbf{b}$  and  $\mathbf{c}$  as illustrated in the image on the right. Then the volume of this object is:



- (a)  $(\mathbf{a} \times \mathbf{b}) \cdot \mathbf{c}$
- (b)  $|\mathbf{a}||\mathbf{b}||\mathbf{c}|$
- (c)  $|\mathbf{a}||\mathbf{b}||\mathbf{c}| \sin \phi$ , where  $\phi$  is the angle between  $\mathbf{c}$  and the plane spanned by  $\mathbf{a}$  and  $\mathbf{b}$
- (d) None of the above

**Question 20:**

If an object is deformed by a transformation matrix  $\mathbf{M}$  then its surface normals must be transformed using the matrix

- (a)  $\mathbf{M}$
- (b)  $\mathbf{M}^{-1}$
- (c)  $\mathbf{M}^T$
- (d) None of the above

**Question 21:**

Given is a sphere with radius  $r$  and center  $\mathbf{c}$  and a line  $\mathbf{p}(t) = \mathbf{q} + t\mathbf{v}$  which does not intersect the sphere. Then the distance between the sphere and the line is computed by the formula:

(a)  $\left| (\mathbf{c} - \mathbf{q}) - \frac{(\mathbf{c} - \mathbf{q}) \cdot \mathbf{v}}{|\mathbf{v}|^2} \mathbf{v} \right| - r$

(b)  $\left| \mathbf{c} - \frac{(\mathbf{c} - \mathbf{q}) \cdot \mathbf{v}}{\mathbf{v} \cdot \mathbf{v}} \mathbf{c} \right| - r$

(c)  $\left| \mathbf{c} - \frac{(\mathbf{c} - \mathbf{q}) \cdot \mathbf{v}}{|\mathbf{c} - \mathbf{q}||\mathbf{v}|} \mathbf{v} \right| - r$

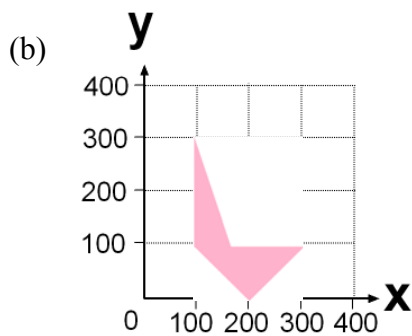
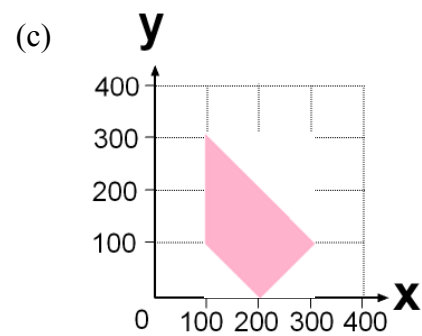
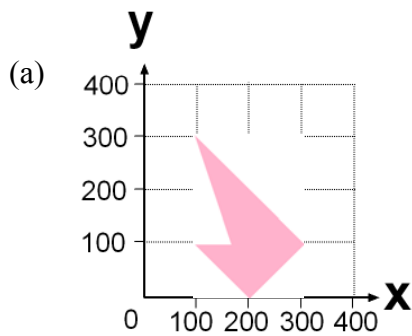
- (d) None of the above

**Question 22:**

Given is an OpenGL program with the display method

```
void display(void)
{
    // clear all pixels in frame buffer
    glClear(GL_COLOR_BUFFER_BIT);
    glColor3f(0.0, 0.0, 0.0);
    glBegin(GL_QUADS);
    glVertex2f(300, 100);
    glVertex2f(100, 300);
    glVertex2f(100, 100);
    glVertex2f(200, 0);
    glEnd();
    glFlush();
}
```

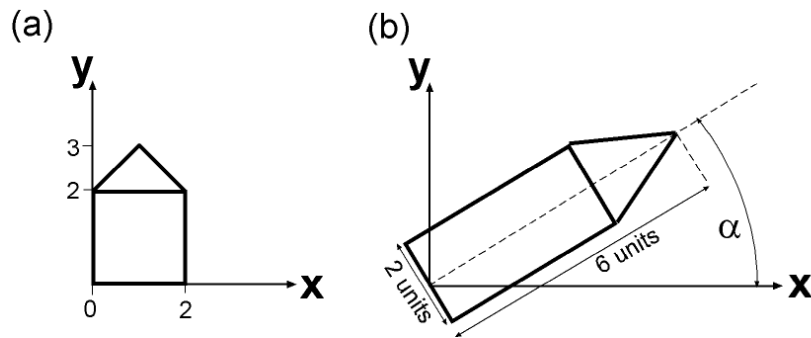
What shape does this display method draw?



(d) None of the above

**Question 23:**

Given is the 2D scene in part (a) of the image below.



The transformation which changes the object shown in (a) into the object in part (b) is achieved by using OpenGL command sequence

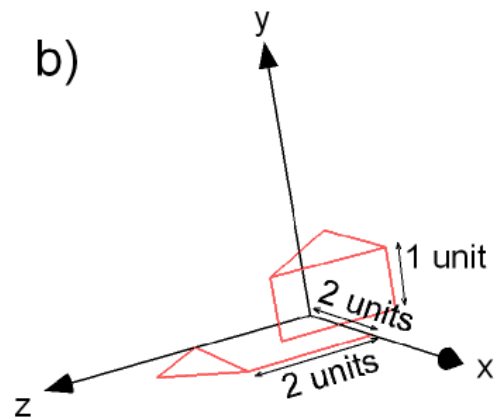
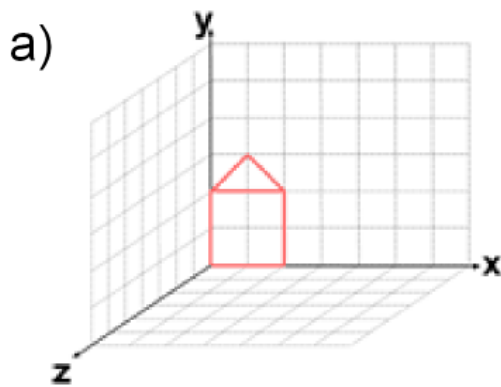
(a) `glMatrixMode(GL_MODELVIEW);`  
`glLoadIdentity();`  
`glRotatef( $\alpha-90$ , 0, 0, 1);`  
`glScalef(1, 2, 1);`  
`glTranslatef(-1, 0, 0);`

(b) `glMatrixMode(GL_MODELVIEW);`  
`glLoadIdentity();`  
`glRotatef( $\alpha$ , 0, 0, 1);`  
`glScalef(1, 2, 1);`  
`glTranslatef(-1, 0, 0);`

(c) `glMatrixMode(GL_MODELVIEW);`  
`glLoadIdentity();`  
`glTranslatef(-1, 0, 0);`  
`glScalef(1, 2, 1);`  
`glRotatef( $\alpha$ , 0, 0, 1);`

(d) None of the above

Given is a function *drawHouse()* which draws a wire frame house in the xy-plane as shown in part (a) of the image below.



The OpenGL transformations for converting this scene into the one shown in part (b) of the image are:

```
glPushMatrix();
// MISSING CODE SEGMENT 1
drawHouse();
glPopMatrix();
// MISSING CODE SEGMENT 2
drawHouse();
```

### Question 24:

The missing code segment 1 in the above program code is

- |  |  |
|--|--|
| (a) <code>glScalef(1, 0.5, 1);</code><br><code>glTranslatef(1, 0, 1);</code><br><code>glRotatef(90, 0, 0, 1);</code> | (c) <code>glRotatef(90, 0, 1, 0);</code><br><code>glTranslatef(1, 0, 1);</code><br><code>glScalef(1, 0.5, 1);</code> |
| (b) <code>glScalef(1, 0.5, 1);</code><br><code>glTranslatef(1, 0, 1);</code><br><code>glRotatef(90, 0, 1, 0);</code> | (d) None of the above  |

### Question 25:

The missing code segment 2 in the above program code is

- |  |  |
|--|--|
| (a) <code>glRotatef(90,0,0,1);</code>  | (c) <code>glRotatef(-90,1,0,0);</code> |
| (b) <code>glRotatef(-90,0,1,0);</code> | (d) None of the above                  |