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TU Delft

Computer Graphics (in2770)
15 June 2004, 14:00 – 16:00 h.

N.B.: This examination contains 30 questions
Total number of pages: 11

Instructions for filling in the Multiple Choice answer form:

- Fill in the form preferably with ballpoint or lead-pencil. Do not use red ink. Do not cross out. Erasing, when using lead-pencil, is allowed.

- Do not forget to fill in your **name**, **branch of science** and **student number**.

- Fill in your **student number** in the student number area **in cipher** and also **by filling in the squares** (check carefully).

Question 1

A window to viewport transformation is defined by a window with boundaries *xwmin* = 40, *xwmax* = 120, *ywmin* = -20, *ywmax* = 80 and a viewport with boundaries *xvmin* = 0.0, *xvmax* = 0.4, *yvmin* = 0.2, *yvmax* = 0.6.
On which point is (60, 20) mapped by this window to viewport transformation?

a. (0.1, 0.3)
b. (0.1, 0.36)
c. (0.2, 0.3)
d. (0.2, 0.36)

Question 2

In programs using OpenGL *idle events* are generated. Which statement about an idle event is correct?

a. An idle event is generated in order to realize that a program does not react any more on user input from a given input device.
b. An idle event is generated in order to indicate that a given input device must be inactive during a certain time.
c. An idle event is generated when the program does not have to handle any other events.
d. An idle event activates an input device that is in idle state.

Question 3

Consider the following statements about texture mapping.

(I) For a bilinear mapping, straight lines (in an arbitrary direction) in texture space are mapped on straight lines in screen space.
(II) For a perspective mapping, straight lines (in an arbitrary direction) in texture space are mapped on straight lines in screen space.

Are these statements correct?

	(I)	(II)
a.	correct	correct
b.	correct	incorrect
c.	incorrect	correct
d.	incorrect	incorrect

Question 4

Consider the scan line algorithm for scan converting a 2D polygon.
In which situation two edges A and B in the Active Edge List must be swapped, when going to the next scan line?

a. When the common endpoint of the edges A and B is in between the current scan line and the next scan line.
b. When the edges A and B intersect each other in between the current scan line and the next scan line.
c. When edge A has a slope sl>0 and edge B a slope sl<0 (or the other way round).
d. When the current scan line intersects only edge A and the next scan line intersects only edge B (or the other way round).

Question 5

The matrix $\begin{pmatrix} 0 & 1 & 1 \\ -1 & 0 & 5 \\ 0 & 0 & 1 \end{pmatrix}$ represents a rotation about point P. What are the coordinates of P?

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

Question 6

Why is the light source often supposed to be at infinite distance in simple reflection models?

a. Only in that situation the light source may be approximated by a point light.
b. Only in that situation the vector **L** in the direction to the light source does not need to be recalculated for every color calculation.
c. Only in that situation the ambient term in the light reflection model is constant through the whole scene.
d. Only in that situation the diffuse reflection component of the light reflection model is independent of the observers position.

Question 7

In computer animation bounding volumes can facilitate collision detection. Consider the following statements:

(I) If the bounding volumes of two objects overlap each other, then the two objects have collided.
(II) If the bounding volumes of two objects do not overlap each other, then the two objects have not collided.

Are these statements correct?

	(I)	(II)
a.	correct	correct
b.	correct	incorrect
c.	incorrect	correct
d.	incorrect	incorrect

Question 8

Which is the correct order in the 3D viewing pipeline for the coordinate systems below?

- modelling coordinates (MC)
- screen coordinates (SC)
- viewing coordinates (VC)
- world coordinates (WC)

a. WC --> MC --> VC --> SC
b. WC --> VC --> MC --> SC
c. MC --> WC --> VC --> SC
d. VC --> WC --> MC --> SC

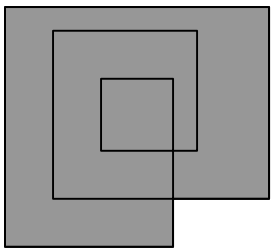
Question 9

Given a system that is able to show animations on a raster screen. The frame rate of the animations shown must be 25 frames per second. The frame buffer contains 24 bits per pixel. If the frame buffer can be written with a velocity of 96000 Kilobyte (1 Kilobyte is 1024 bytes) per second, then what is the maximal size of the window that is used to show the animation?

a. 1280 x 1024
b. 1024 x 1024
c. 640 x 512
d. 320 x 128

Question 10

Consider the image below of a polygon with crossing edges.



According to which rule(s) the polygon is colored in the same way as in the image?

a. according to the 'odd even' rule and according to the 'nonzero winding number' rule
b. only according to the 'odd even' rule
c. only according to the 'nonzero winding number' rule
d. not according to the 'odd even' rule and also not according to the 'non zero winding number' rule

Question 11

Which OpenGL functions are needed to create a hierarchical menu, besides `glutAttachMenu` which attaches a mouse button to the (main) menu?

a. `glutCreateMenu` and `glutAddMenuEntry`
b. `glutCreateMenu`, `glutCreateSubMenu` and `glutAddMenuEntry`
c. `glutCreateMenu`, `glutAddMenuEntry` and `glutAddSubMenu`
d. `glutCreateMenu`, `glutCreateSubMenu`, `glutAddMenuEntry` and `glutAddSubMenu`

Question 12

A triangle PQR in *uv*-texture space is mapped on a triangle ABC in *xy*-screen space with the affine mapping $\begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = \begin{pmatrix} a & b & c \\ d & e & f \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} u \\ v \\ 1 \end{pmatrix}$.

P is mapped on A, Q on B and R on C. The coordinates of the points involved are given in the table below:

point in texture space	*u*	*v*	point in screen space	*x*	*y*
P	0	0	A	1	3
Q	0.5	0	B	7	3
R	0	1	C	4	5

What is the value of *a* in the matrix representing this mapping?

a. 6
b. 7
c. 12
d. 14

Question 13

We want to map a texture on a polygon with use of antialiasing. What is an advantage of the use of pre-filtering with a mip-map?

a. When using a mip-map less memory space is used than without using a pre-filtering method.
b. When using a mip-map the texture is displayed with higher quality than without using a pre-filtering method.
c. When using a mip-map the texture is displayed on the polygon with a perspective mapping, while without pre-filtering it is not displayed with a perspective mapping.
d. When using a mip-map the calculation time is independent of the texture compression on the polygon, while without pre-filtering it is dependent on the texture compression.

Question 14

A certain oblique projection displays lines, perpendicular to the projection plane, at half their real size. The projection direction makes an angle α with the projection plane. What holds for α ?

a. $\sin\alpha = \frac{1}{2}$ b. $\cos\alpha = \frac{1}{2}$ c. $\tan\alpha = \frac{1}{2}$ d. $\tan\alpha = 2$

Question 15

In behalf of the painter's algorithm a depth sort is applied to all polygons in reverse depth order (i.e. the polygon with largest depth relative to the observer is the first polygon in the list after sorting).
During this depth sorting, for pairs of polygons S and S', with S in front of S' in the list, is determined whether the polygons may stay in the given order relative to each other or not. Therefore, several tests are performed. What is not one of these tests?

a. All vertices of S are at one side of the plane of S' and the observer is at the other side of this plane.
b. All vertices of S have greater depth measured from the observer than all vertices of S'.
c. S and S' do not overlap in x-direction or do not overlap in y-direction.
d. S and S' do not overlap in z-direction.

Question 16

Which shading method can also be denominated as *normal vector interpolation shading* ?

a. Phong shading
b. Gouraud shading
c. curved surface shading
d. flat shading

Question 17

In which component of a simple light reflection model Lambert's cosine law is used?

a. the ambient component
b. the refraction component
c. the diffuse reflection component
d. the specular reflection component

Question 18

What is the correct matrix for 2D mirroring in the line y = 1 ?

a. $\begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & -2 \\ 0 & 0 & 1 \end{pmatrix}$ b. $\begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 2 \\ 0 & 0 & 1 \end{pmatrix}$ c. $\begin{pmatrix} -1 & 0 & 0 \\ 0 & 1 & -2 \\ 0 & 0 & 1 \end{pmatrix}$ d. $\begin{pmatrix} -1 & 0 & 0 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{pmatrix}$

Question 19

A viewing coordinate system is determined by the center of projection (COP), the view reference point (VRP) and the view up vector (VUV). The COP is the viewing coordinate systems origin. The VRP lies on the viewing coordinate systems negative z-axis.
Given is (in world coordinates): COP = (0, 0, 0), VRP = (1, 1, 0) and VUV = (-2 1 0).
What is the correct matrix for this viewing transformation?

a. $\begin{pmatrix} 0 & 0 & 1 & 0 \\ -\frac{1}{2}\sqrt{2} & -\frac{1}{2}\sqrt{2} & 0 & 0 \\ -\frac{1}{2}\sqrt{2} & \frac{1}{2}\sqrt{2} & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$

b. $\begin{pmatrix} 0 & 0 & 1 & 0 \\ -\frac{1}{2}\sqrt{2} & \frac{1}{2}\sqrt{2} & 0 & 0 \\ -\frac{1}{2}\sqrt{2} & -\frac{1}{2}\sqrt{2} & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$

c. $\begin{pmatrix} -\frac{1}{2}\sqrt{2} & -\frac{1}{2}\sqrt{2} & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -\frac{1}{2}\sqrt{2} & \frac{1}{2}\sqrt{2} & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$

d. $\begin{pmatrix} -\frac{1}{2}\sqrt{2} & \frac{1}{2}\sqrt{2} & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -\frac{1}{2}\sqrt{2} & -\frac{1}{2}\sqrt{2} & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$

Question 20

The 3D Cohen and Sutherland line clipping algorithm uses for 6-bits codes of line endpoints and as clipping order: left, right, below, above, before, behind.
Which of the following 6-bits codes is <u>not</u> a correct code for an endpoint of a line to be clipped?

a. 010101
b. 011000
c. 001100
d. 100110

Question 21

When making an image of a 3D scene, which method / algorithm completely solves the problem to determine the visible surfaces?

a. z-buffer algorithm
b. DDA algorithm
c. back face removal
d. Liang and Barsky algorithm

Question 22

When the boundary of a region to be filled has already been drawn in the frame buffer, then the interior can be colored using a fill algorithm. This is used in paint programs.
In practice, instead of the 4-connected or the 8-connected boundary fill algorithm, a fill algorithm is often used, that colors spans and stores pixels on spans above and below the current span on a stack for later use.
Why is this last fill algorithm normally used instead of the boundary fill algorithm?

a. The algorithm that colors spans is easier to implement than the boundary fill algorithm.
b. The algorithm that colors spans is more efficient than the boundary fill algorithm.
c. Both the 4-connected and the 8-connected boundary fill algorithm cannot color correctly certain types of polygons. The algorithm that colors spans does not have this problem.
d. The algorithm that colors spans does not need a start pixel. However, the boundary fill algorithm does.

Question 23

Consider the following statements about two-dimensional transformations:

(I) Homogeneous coordinates are necessary in order to represent a translation by a matrix.
(II) Homogeneous coordinates are necessary in order to represent an elementary shearing transformation by a matrix.

Are these statements correct?

	(I)	(II)
a.	correct	correct
b.	correct	incorrect
c.	incorrect	correct
d.	incorrect	incorrect

Question 24

Consider the OpenGL function call `glPopMatrix();`
Which matrix is stored on the stack at this call?

a. the viewing transformation matrix
b. the current transformation matrix
c. the model-view matrix
d. the projection matrix

Question 25

Given is that point P(3, 2, 5) lies in plane V. The vector $\begin{pmatrix} 2 \\ -4 \\ 1 \end{pmatrix}$ is a normal vector of plane V.

What is the plane equation of V?

a. $2x - 4y + z - 21 = 0$
b. $2x - 4y + z - 3 = 0$
c. $3x + 2y + 5z - 38 = 0$
d. $3x + 2y + 5z - 3 = 0$

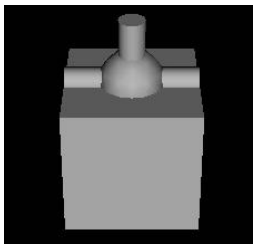
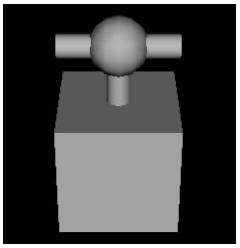
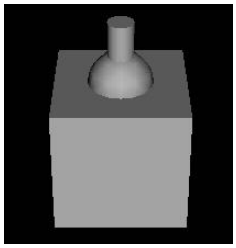
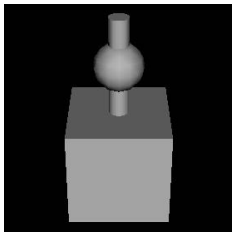
Question 26

Consider the following VRML virtual world:

```
#VRML V2.0 utf8
Shape {
  appearance DEF Yellow Appearance
{
    material Material {
      diffuseColor .8 .8 .2
    }
  }
  geometry Box {}
}
Transform {
  translation 0 1 0
  children [
    Shape {
      appearance USE Yellow
      geometry Cylinder {
        radius 0.2
      }
    }
  ]
}
```

```
Transform {
  translation 0 2 0
  children [
    Shape {
      appearance USE Yellow
      geometry Sphere {
        radius 0.5
      }
    }
    Transform {
      rotation 0 0 1 1.57
      children Shape {
        appearance USE Yellow
        geometry Cylinder {
          radius 0.2
        }
      }
    }
  ]
}
```

What does the model defined in this world look like?

a.  b.  c.  d. 

Question 27

In a VRML virtual world an object with name `RotatingObject` is defined. In order to make this object rotate about the y-axis, the following code fragment is put in the VRML file:

```
DEF Rot OrientationInterpolator {
  key [0.0 0.125 0.25 0.375 0.5 0.625 0.75 0.875 1.0]
  keyValue [ 0 1 0 0.0
             0 1 0 3.14
             0 1 0 1.57
             0 1 0 4.71
             0 1 0 3.14
             0 1 0 6.28
             0 1 0 4.72
             0 1 0 1.57
             0 1 0 0.0 ]
}

DEF Timer TimeSensor {
  loop TRUE
  cycleInterval 20
}

ROUTE Timer.fraction_changed TO Rot.set_fraction
ROUTE Rot.value_changed TO RotatingObject.set_rotation
```

How many degrees (approximately) the object `RotatingObject` is rotated about the y-axis (counterclockwise when observed from the positive y-axis) relative to its original orientation at a time instance 11 seconds after the start of a cycle?

a. 72 graden
b. 189 graden
c. 234 graden
d. 252 graden

Question 28

A projection in which the projectors make a 45º angle with the projection plane is called

a. orthographic projection
b. isometric projection
c. perspective projection
d. cavalier projection

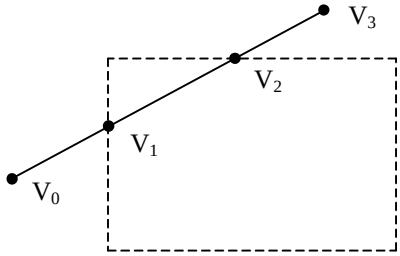
Question 29

The geometry field of a Shape node in a VRML file has a field value of type

a. MFVec3f
b. SFVec3f
c. MFNode
d. SFNode

Question 30

The figure below shows a window (with dashed lines) against which a polygon is clipped. One edge V_0V_3 of the polygon is displayed. To clip the polygon the Sutherland Hodgman polygon clipping algorithm is used. The clipping order against the window boundaries is left, right, below, above.



Which points are stored in the output polygon during clipping *against the left window boundary*?

a. V_1, V_2 and V_3
b. only V_1 and V_2
c. only V_1 and V_3
d. only V_1

end of examination