CompSci 373 S1 C 2011
Computer Graphics and Image Processing

Mid Term Test – Tuesday, 10th May 2011, 6.30 pm – 7.30 pm

VERSION CODE 00000001

Instructions:

1. Enter your *name*, *student ID* and the *version number* shown on the top left into the teleform sheet supplied. Your name should be entered left aligned. If you have a middle initial, enter it under MI. If your name is longer than the number of boxes provided, truncate it.
2. Use a dark pencil to mark your answers on the teleform sheet supplied. If you spoil your sheet, ask the exam supervisor for a replacement. Writing on this question book will **NOT be marked**.
3. If you want to change your answer **erase the previously filled in box completely** using an eraser.
4. All questions must be answered in the multiple choice answer boxes on the teleform sheet corresponding to the respective question number. There is only one correct answer for each question.
5. **Questions total 50 Marks**. Each question is worth 2 marks.
6. Attempt **ALL** questions.
7. The test is for 60 minutes.
8. This is a **closed book** test.
9. Calculators and electronic devices are **NOT** permitted.
10. This test is worth 20% of your final marks for CompSci373 S1 C

Question 1:

Which statement about coordinates is *false?* If you believe that all statements (a) to (d) are false, then please choose answer (e).

(a) The **Cartesian** coordinate system is defined as a set of parallel axes with numbers (coordinates)
(b) The **Origin** is where coordinates are equal to zero
(c) A **Point** is a position in space given as a set of coordinate values
(d) A **Vector** is a displacement/difference between two points
(e) None of the others

Question 2:

Which statement about homogeneous transform is *true*?

(a) It is a 3D representation of a 2D Cartesian point
(b) It is a 2D representation of a 3D Cartesian point
(c) It is used to represent matrices but cannot represent points or vectors
(d) It is a convenient way to deal with matrices additions but serves no purpose for matrices multiplication
(e) None of the others

Question 3:

Which statement about Spectral Density Function (SDF) is *true*?

(a) Each different colour perceived by humans corresponds to a unique SDF
(b) The Spectral Density Function (SDF) describes the wave composition of light with power for each wave length segment
(c) The Spectral Density Function for light sources is limited to the visible human spectrum
(d) White/gray Light sources have a unique spike (e.g. wavelength) Spectral Density Function spectrum
(e) None of the others

Question 4:

Which statement about color systems is *true*?

(a) In a subtractive color system, colors are mixed by adding appropriate amounts of primary colors to black
(b) In an additive color system, colors are mixed by subtracting appropriate amounts of primary colors from white
(c) In the Hue, Saturation, Value color space, Saturation indicates the dominant color perceived
(d) (r,g,b) = (1,1,1) + (c,m,y)
(e) None of the others

CONTINUED

Question 5:

Which statement about color systems is *false*? If you believe that all statements (a) to (d) are false, then please choose answer (e).

(a) Colors can be represented using a 3D color space
(b) RGB is easy to use for subtractive color mixing
(c) CIE can represent all visible colors
(d) HSL can linearly interpolate properly between hue, saturation and lightness components
(e) None of the others

Question 6:

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

(a) 5
(b) 8
(c) 11
(d) -14
(e) None of the others

Question 7:

Which statement about the cross product is *true*?

(a) The cross product of two vectors of the same dimension is a matrix
(b) The cross product of two vectors of the same dimension is a scalar
(c) The cross product of two vectors of the same dimension is a vector
(d) The cross product of two vectors of the same dimension is not defined
(e) None of the others

Question 8:

The cross product **u**×**v** where $\mathbf{u} = \begin{pmatrix} -1 \\ 1 \\ 3 \end{pmatrix}$ and $\mathbf{v} = \begin{pmatrix} 2 \\ 1 \\ 0 \end{pmatrix}$ equals

a) $\begin{pmatrix} -3 \\ 6 \\ 3 \end{pmatrix}$

b) -1

c) $\begin{pmatrix} -2 & -1 & 0 \\ 2 & 2 & 0 \\ 6 & 3 & 0 \end{pmatrix}$

d) not defined

e) None of the others

Question 9:

A plane with the following plane equation is given: $x + 2y - 2z = 3$.
How far away is the point (2,2,3) from the plane?

(a) 0
(b) 3
(c) 9
(d) 8/3
(e) None of the others

Question 10:

A plane with the following plane equation is given: $x + 2y - 2z = 3$.
How far away is the origin from the plane?

(a) 1
(b) 3
(c) 9
(d) 8/3
(e) None of the others

CONTINUED

Question 11:

What is the equation of the plane, which is orthogonal to $\mathbf{u} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$ and contains the point $A = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$?

(a) $x + y + z = 3$
(b) $3x - y - z = 1$
(c) $x + y + z = -3$
(d) $x - y + z = 1$
(e) None of the others

Question 12:

Which statement about affine transformations is *true*?

(a) An affine transformation is always linear
(b) The order in which affine transformations are performed only matters when scaling is involved
(c) With homogeneous coordinates, affine transformations can be expressed using only matrix addition
(d) Affine transformations can bend a straight line
(e) None of the others

Question 13:

Assume **A** and **B** are 3x1 matrices (i.e. column vectors), and **I** is the 3x3 identity matrix. Which of the following statements is *false*? If you believe that all statements (a) to (d) are false, then please choose answer (e).

(a) The dot product of **B** and **A** is equal to the dot product of **A** and **B**, i.e. **A.B = B.A**
(b) the matrix product of the transpose of vector **A** and **B** is equal to the matrix product of the transpose of vector **B** and **A**, i.e. $\mathbf{A}^T\mathbf{B} = \mathbf{B}^T\mathbf{A}$
(c) The matrix product of the transpose of vector **A** and **A** is the magnitude of **A**, i.e. $\mathbf{A}^T\mathbf{A}=|\mathbf{A}|$
(d) The cross product of **A** and **B** creates a vector which is orthogonal to vectors **A** and **B**, i.e. $(\mathbf{A}\times\mathbf{B}).\mathbf{A} = \mathbf{B}.(\mathbf{A}\times\mathbf{B}) = 0$
(e) None of the others

Question 14:

At which part of the OpenGL graphics pipeline is illumination performed?

(a) Before the MODELVIEW transformation
(b) Between the MODELVIEW transformation and PROJECTION transformation
(c) Between the PROJECTION transformation and viewport transformation
(d) Between the viewport transformation and rasterisation
(e) None of the above

Question 15:

Which statement about OpenGL is *false*? If you believe that all statements (a) to (d) are false, then please choose answer (e).

(a) The OpenGL Shading Language (GLSL) enables programmers to replace the OpenGL fixed-function vertex and fragment processing
(b) WebGL is a binding for JavaScript to OpenGL ES 2.0
(c) OpenGL allows hardware accelerated rendering, texture-mapping and special effects
(d) OpenGL runs only on Microsoft operating systems
(e) The OpenGL 4.0 standard improves interoperability with OpenCL in order to enable general purpose applications to be executed on the GPU

Question 16:

In the lecture we learned that gluOrtho2D is implementing a world-to-viewport mapping. Given is a world window with the left bottom corner (0,0) and the top-right corner (100,200). What is the homogeneous matrix mapping this world window into a window on the screen (viewport), which is aligned with the top-left corner of the screen and has a width of 100 pixels and height of 200 pixels?
TIP: Make yourself an illustration. Keep in mind the different positions of the world and screen coordinate system. You can solve this question either by using the formula derived in the lecture, or easier, by just thinking about the meaning of the different components of the world-to-viewport mapping.

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

(b) $\begin{pmatrix} 1 & 0 & 100 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

(c) $\begin{pmatrix} -1 & 0 & 100 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

(d) $\begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 200 \\ 0 & 0 & 1 \end{pmatrix}$

(e) $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 200 \\ 0 & 0 & 1 \end{pmatrix}$

Question 17:

The picture on the right shows an object created with `Blender` by combining several Bezier curves, extending the resulting 2D shape in a third dimension, and then rounding the resulting objects's edges and corners.

Which of the modeling techniques below was **NOT** used in the creation of this object?

(a) Subdivision surfaces
(b) Parametric curves and/or surfaces
(c) Extruded surfaces
(d) Implicit surfaces
(e) All techniques above were used

Question 18:

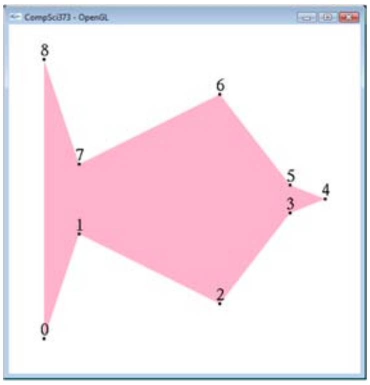
How many triangles are drawn if we use the drawing mode `GL_TRIANGLE_STRIP` with six vertices between `glBegin(GL_TRIANGLE_STRIP)` and `glEnd()`?

(a) 1
(b) 2
(c) 3
(d) 4
(e) None of the above

Question 19:

Given are the vertices

```
const int numVertices=9;
const float vertices[numVertices][2] =
   {{50,50},{100,200},{300,100},
    {400,230},{450,250},{400,270},
    {300,400},{100,300},{50,450}};
```



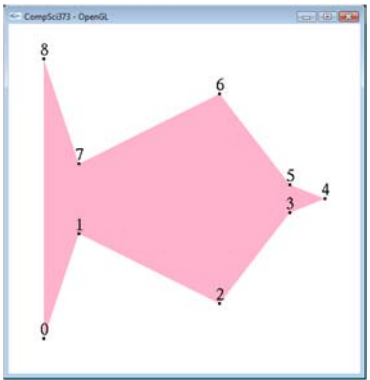
Which calling sequence of these vertices (using `glVertex2fv`) results in the shape on the right if we use the OpenGL commands `glBegin(GL_TRIANGLE_FAN)` and `glEnd()`?

(a) 0, 1, 2, 3, 4, 5, 6, 7, 8
(b) 1, 2, 3, 4, 5, 6, 7, 8, 0
(c) 2, 3, 4, 5, 6, 7, 8, 0, 1
(d) 3, 4, 5, 6, 7, 8, 0, 1, 2
(e) None of the above

Question 20:

Given are the vertices

```
const int numVertices=9;
const float vertices[numVertices][2] =
   {{50,50},{100,200},{300,100},
    {400,230},{450,250},{400,270},
    {300,400},{100,300},{50,450}};
```



Which calling sequence of these vertices (using `glVertex2fv`) results in the shape on the right if we use the OpenGL commands `glBegin(GL_TRIANGLE_STRIP)` and `glEnd()`?

(a) 0, 1, 2, 3, 4, 5, 6, 7, 8
(b) 0, 1, 8, 7, 6, 2, 3, 5, 4
(c) 0, 8, 1, 7, 2, 6, 3, 5, 4
(d) 1, 2, 3, 4, 5, 6, 7, 8, 0
(e) None of the above

Question 21:

Which modelview matrix is generated by the following code segment?

```
glMatrixMode(GL_MODELVIEW);
glLoadIdentity();
glTranslatef(1, 0, 0);
glRotatef(φ, 0, 0, 1);
glTranslatef(0, 2, 0);
```

(a) $$\begin{pmatrix} \cos\varphi & -\sin\varphi & 0 & -\sin\varphi \\ \sin\varphi & \cos\varphi & 0 & \cos\varphi+2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

(b) $$\begin{pmatrix} \cos\varphi & -\sin\varphi & 0 & -2\sin\varphi+1 \\ \sin\varphi & \cos\varphi & 0 & 2\cos\varphi \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

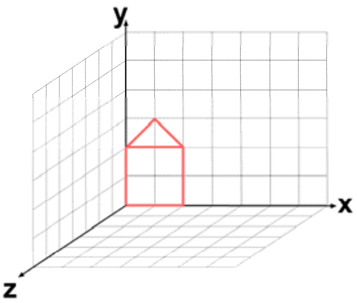
(c) $$\begin{pmatrix} \cos\varphi & \sin\varphi & 0 & \sin\varphi \\ -\sin\varphi & \cos\varphi & 0 & \cos\varphi+2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

(d) $$\begin{pmatrix} \cos\varphi & \sin\varphi & 0 & 2\sin\varphi+1 \\ -\sin\varphi & \cos\varphi & 0 & 2\cos\varphi \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

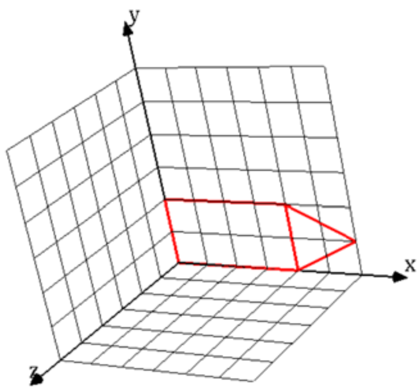
(e) None of the above

Question 22:

Given is a function *drawHouse()* which draws a wire frame house in the xy-plane as shown in the image on the right:



Which code segment results in the transformed house in the picture below?



(a)
```
glMatrixMode(GL_MODELVIEW);
glLoadIdentity();
glScalef(2, 1, 1);
glRotatef(-90, 0, 0, 1);
drawHouse();
```

(b)
```
glMatrixMode(GL_MODELVIEW);
glLoadIdentity();
glRotatef(90,0,0,1);
glRotatef(90,1,0,0);
glScalef(1,2,1);
drawHouse();
```

(c)
```
glMatrixMode(GL_MODELVIEW);
glLoadIdentity();
glScalef(2, 1, 1);
glRotatef(90, 0, 0, 1);
glRotatef(180, 1, 0, 0);
drawHouse();
```

(d)
```
glMatrixMode(GL_MODELVIEW);
glLoadIdentity();
glRotatef(90,0,0,1);
glScalef(1,2,1);
glRotatef(90,0,1,0);
drawHouse();
```

(e) None of the above

Question 23:

In the lecture we discussed how a surface of revolution can be obtained by rotating a profile curve **c**(t)=(x(t), 0, z(t)) around the z-axis.

Given is a profile curve **c**(t)=(x(t), y(t), 0) in the xy-plane. What is the parametric equation of the surface-of-revolution obtained by rotating this curve around the y-axis?

(a) $\begin{pmatrix} x(t)\cos\varphi \\ y(t)\cos\varphi \\ x(t)\sin\varphi \end{pmatrix}$

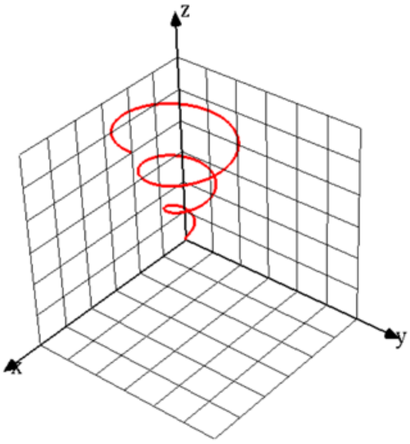
(b) $\begin{pmatrix} x(t)\cos\varphi \\ x(t)\sin\varphi \\ y(t) \end{pmatrix}$

(c) $\begin{pmatrix} x(t)\cos\varphi \\ y(t) \\ x(t)\sin\varphi \end{pmatrix}$

(d) $\begin{pmatrix} x(t) \\ y(t)\cos\varphi \\ y(t)\sin\varphi \end{pmatrix}$

(e) None of the above

Question 24:



The picture on the right shows a parametric curve which is a spiral with 3 revolutions, a height of 4 units, and a radius rising from 0 to 2 units. The spiral starts at the origin and its centre axis is the z-axis.
What is the parametric equation of this curve?

(a) $\begin{pmatrix} 2\cos(3\pi t) \\ 2\sin(3\pi t) \\ 4t \end{pmatrix}$

(b) $\begin{pmatrix} 3t\cos(6\pi t) \\ 3t\sin(6\pi t) \\ 4 \end{pmatrix}$

(c) $\begin{pmatrix} 2\cos(3\pi t) \\ 2\sin(3\pi t) \\ 4 \end{pmatrix}$

(d) $\begin{pmatrix} 2t\cos(6\pi t) \\ 2t\sin(6\pi t) \\ 4t \end{pmatrix}$

(e) None of the above

Question 25:

The image below on the left is used to texture map a quadrilateral as illustrated in the image below on the right. The bottom-left vertex of the quadrilateral has the texture coordinates (0, 0).

Texture image

Texture mapped quadrilateral

What are the texture coordinates of the other three vertices?

(a) Bottom-right vertex: (1, 0); Top-left vertex: (0.5, 1); Top-right vertex: (2, 0)
(b) Bottom-right vertex: (1, 0); Top-left vertex: (1, 1); Top-right vertex: (2, 0)
(c) Bottom-right vertex: (1, 0); Top-left vertex: (0.5, 1); Top-right vertex: (1, 1)
(d) Bottom-right vertex: (1, 0); Top-left vertex: (0, 1); Top-right vertex: (1, 1)
(e) None of the above