Student Name:

Student Number:

# Computer Graphics – TI1806

*Duration: max. 2 hours*

*The questions have an indication of how many points they represent. For a correct answer these points are added;* ***for a wrong answer they are subtracted.*** *Nothing is added or subtracted if no answer is given. In short:* ***Guessing can have a negative impact!*** *We suggest you keep the questions marked with * for the end.*

*Please answer all multiple choice questions on the dedicated page. Good luck!*

## Ray Tracing and Rasterization

1. (1 point) * Given the point P=(1,2,3), at what distance is it located from the plane with the normal n in direction (1,1,0) and passing through the point Q=(1,0,3).

a) $\sqrt{2}$ b) $1/\sqrt{2}$ c) 2 d) 1

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2. (1 point) Let A, B, C, V, W be vectors in $R^3$. Given the two statements below:

i) Let P:=A+b*(B-A)+c*(C-A), with b, c real numbers. P is on the triangle (A,B,C) if and only if 0<= b+c <=1 and 0<=b<=1 and 0<=c<=1

ii) Let P:=A+b*V+c*W, with b, c real numbers. P lies inside the quad (A,A+V,A+V+W, A+W) if and only if 0<=b<=1 and 0<=c<=1

a) Statement i) and statement ii) are true
b) only statement i) is true
c) only statement ii) is true
d) both statements are false

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3. (1 point) Which of the following statements is NOT true?

a) Today's graphics cards are typically optimized for rasterization
b) Let n be the normal of the triangle A, B, C, points in $R^3$. Then n.(A-C)= n.(B-C)=0
c) Let k be an integer. Any triangle mesh with k vertices has less than k triangles.

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4. (1 point) Assume a projector placed at 1m from the wall projects an image of 1 $m^2$ orthogonally on a wall. If the projector is pulled back by 1m (now 2m from the wall), the projected image has

a) 1 $m^2$ b) 2 $m^2$ c) 3 $m^2$ d) 4 $m^2$

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5. (1 point)* Calculate the intersection point P of the triangle, given by the points (1,1,1), (1,2,1), (2,2 and the ray through (1,0,2) in direction (1,1,0)

a) P=(2,1,2) b) P=(1,2,1) c) there is no intersection d) there are infinite intersections

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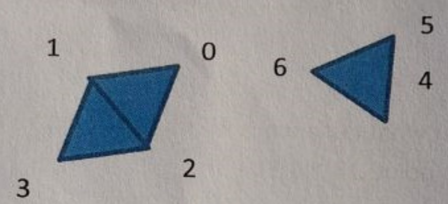
6. (0.5 Point) Assuming the triangles in the drawing with vertex indices shown in the drawing. Which of the following index buffers is a valid buffer for this mesh (regardless of winding).

a) {5,6,4,1,2,0,1,3,2}
b) {3,0,2,5,6,4,1,3,2}
c) {1,0,2,6,4,2,1,3,2}
d) {1,3,2,1,0,1,5,6,4}

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## Homogeneous Coordinates

7. (1 point) Given the following matrices and the point P=(0,1,3) in a **projective space**, which of the matrices transforms P into the point (0,1,1).

i) $\begin{bmatrix} 3 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 3 \end{bmatrix}$ ii) $\begin{bmatrix} 2 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 2 & 1 \end{bmatrix}$ iii) $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

a) Only i b) Only ii c) Only i and ii d) Only ii,iii

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8. (0.5 points) Following the course, in a 3 dimensional projective space, the matrix below is a...

$$\begin{bmatrix} \cos(2) & -\sin(2) & 0 & 0 \\ \cos(2) & \cos(2) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

a) translation b) rotation c) scaling matrix d) none of these

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9. (1.5 points) * Given the following camera projection matrix

$$M := \begin{bmatrix} \frac{f}{aspect} & 0 & 0 & 0 \\ 0 & f & 0 & 0 \\ 0 & 0 & \frac{near+far}{near-far} & \frac{2near\,far}{near-far} \\ 0 & 0 & -1 & 0 \end{bmatrix}$$

Which projective point when applying M results in (1,1,1,1)?

a) (aspect/f,1/f, far, 1)

b) (aspect*far, far, -(f*far), f)

c) (aspect/f, 1/f, -1, 1)

d) (aspect, 1, -(f*far), 1)

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10. (1 point) * Given a fragment with normalized device coordinates (x,y,1), give the 3x3 transformation matrix to map this fragment to the correct pixel location on a screen with resolution (1024,768), and pixel location (0,0) at the **top left** corner.

a) $\begin{bmatrix} 512 & 0 & 512 \\ 0 & -384 & 384 \\ 0 & 0 & 1 \end{bmatrix}$ b) $\begin{bmatrix} 512 & 0 & 512 \\ 0 & 384 & 384 \\ 0 & 0 & 1 \end{bmatrix}$ c) $\begin{bmatrix} 1024 & 0 & 0 \\ 0 & 768 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ d) $\begin{bmatrix} 1024 & 0 & 1024 \\ 0 & -768 & 768 \\ 0 & 0 & 1 \end{bmatrix}$

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## Shading and Textures

11. (1 point) Given the texture on the left (see indicated UV coordinates), please indicate the texture coordinates on the corners A,B,C of the triangle (right) to reproduce the shown result:

(1,1)

(0,0) (1,0)

C

A B

a) A with (1,0), B with (0.5,1), C with (0.5,0)

b) A with (1,0), B with (0.5,1), C with (0,0.5)

c) A with (1,0), B with (1,1), C with (0.5,1)

d) A with (1,0), B with (0.5,1), C with (1,0.5)

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12. (1 point) Assuming a plane P with normal (0,0,1) passing through the origin. Assuming P is a mirror surface, and we want to illuminate the point (1,2,1) from a light source at (-1,-2,1), which of the following vectors defines the direction in which we have to emit light if we want the light to reflect from the surface?

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

13. (1 point) * Given a triangle with texture coordinates Ti on each vertex Vi, where Ti is the texture coordinate of Vi, with V1=(1,0,0), T1=(2,2), V2=(2,1,2), T2=(0,4), V3=(3,2,1), T3=(1,0). What texture coordinates do you obtain for the position (2,1,1)?

a) (1,2) b) (0.5,0.5) c) (0.5, 2) d) (0.5, 1) e) (1,1)

14. (1 point) Given the grayscale texture (each value in [0,1]) below (bottom left corresponding to texture coordinate (0,0), the top right to (1,1), and the bottom right to (1,0)), which value has to be in the position X, such that the result of a bilinear texture lookup with coordinates (2/3, 1/2) results in 0.5?

$$\begin{bmatrix} 1 & 0 & 1 \\ 0.5 & 0.2 & X \\ 0.5 & 1 & 0.5 \end{bmatrix}$$

a) 0.2 b) 0.4 c) 0.6 d) 0.8 e) 1.0

Given a camera at position (-1,-1,1), a surface point P at position (1,0,0), a normal in direction (0,0,1) and a light source at position (2,1,1).

15. (1 points) Assuming a surface reflectance of 1 at P and the diffuse illumination model. What intensity should the light have such that the result of the diffuse model at P would be 1/3?

a) 1 b) 1/sqrt(3) c) 1/3 d) 1/2

16. (1 Point) Assuming a specular coefficient/shininess of 1, what is the result of applying the Phong Model for P with a specular light intensity of 1? Ignore diffuse or ambient components.

a) 1 b) 1/sqrt(3) c) 1/3 d) 1/2

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17. (0.5 points) Which of the following statements are true:

i) Bilinear interpolation is useful to hide insufficient texture resolution.
ii) Mipmapping is useful when the texture resolution is too high compared to its presentation on screen

a) Both are true    b) none is true    c)only i)    d) only ii)    b)

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Given the texture below (storing floating point values in [0,255]):

$$\begin{bmatrix} 1 & 1 & 2 & 0 & 1 & 1 & 0 & 2 \\ 1 & 1 & 2 & 0 & 1 & 1 & 0 & 0 \\ 2 & 0 & 1 & 2 & 1 & 1 & 0 & 2 \\ 0 & 2 & 0 & 1 & 1 & 1 & 0 & 0 \\ 2 & 3 & 2 & 2 & 1 & 1 & 0 & 2 \\ 0 & 1 & 1 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 2 \end{bmatrix}$$

18. (1 point) This texture being level 0, what value will be located on level 2 in the upper left corner?

a) 1    b) 2    c) 3    d) 4

19. (1 point) How many pixels/texels will be in mipmap level 2?

a) 1    b) 4    c) 8    d) 16

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## Shadows

20. (1 point) In order to determine whether a point is lit or shadowed using shadow mapping, we compare the depth of the point from the light with the depth value of the corresponding shadow-map texel. As seen in class, an offset can reduce self-shadowing. If you are to take surface orientation into account, how should the bias generally be changed when the dot product between light direction and normal decreases?

a) the bias should increase    b) the bias should decrease    c ) the bias should not change

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21. (1 point) Which of the following statements are true:

i) Assuming infinite resolution, you can compute accurate soft shadows from a shadow map
ii) Using shadow mapping with a standard projection matrix, doubling the depth precision will double The precision of the shadow test everywhere.

a) Both are true    b) none is true    c)only i)    d) only ii)

Correct:

1. A
2. A
3. C
4. D
5. C
6. A
7. D
8. D
9. B
10. A
11. A
12. A
13. A
14. D
15. B
16. A
17. A
18. A
19. B
20. A
21. B