北京郵電大學

Queen Mary University of London

EBU5405 A

Complete the information below about yourself very carefully.

QM student number										
BUPT student number										
Class number										

Joint Programme Examinations 2015/16

EBU5405 3D Programming Tools

Paper A

Answer ALL questions

NOT allowed: electronic calculators and electronic dictionaries.

For examiners' use only

1	
2	
3	
4	
Total	

INSTRUCTIONS

1. **You must not take answer books, used or unused, from the examination room.**
2. Write only in black or blue pen **and in English**.
3. Do all rough work in the answer book – **do not tear out any pages**.
4. If you use Supplementary Answer Books, tie them to the end of this book.
5. Write clearly and legibly.
6. **Read the instructions on the inside cover.**

Examiners

Dr Marie-Luce Bourguet, Dr Yizhe Song

Filename: 1516_EBU5405_A No answerbook required

Instructions

Before the start of the examination

1) Place your BUPT and QM student cards on the corner of your desk so that your picture is visible.

2) Put all bags, coats and other belongings at the back/front of the room. All small items in your pockets, including wallets, mobile phones and other electronic devices must be **placed in your bag in advance**. **Possession of mobile phones, electronic devices and unauthorised materials is an offence.**

3) Please ensure your mobile phone is switched off and that no alarm will sound during the exam. **A mobile phone causing a disruption is also an assessment offence.**

4) Do not turn over your question paper or begin writing until told to do.

During the examination

1) You must not communicate with or copy from another student.

2) If you require any assistance or wish to leave the examination room for any reason, please raise your hand to attract the attention of the invigilator.

3) If you finish the examination early you may leave, but not in the first 30 minutes or the last 10 minutes.

4) For 2 hour examinations you may **not** leave temporarily.

5) For examinations longer than 2 hours you **may** leave temporarily but not in the first 2 hours or the last 30 minutes.

At the end of the examination

1) You must stop writing immediately – **if you continue writing after being told to stop, that is an assessment offence.**

2) Remain in your seat until you are told you may leave.

Question 1

a) Consider the following statement: "3D Graphics is created in real-time if the computer can process input as fast as or faster than the input is being supplied".

[6 marks]

i) What is the nature of the inputs in 3D Graphics?

(2 marks)

ii) What is the nature of the output?

(2 marks)

iii) What is the architecture used for real-time 3D graphics?

(2 marks)

	Do not write in this column
	6 marks

b) Briefly explain how the following two techniques contribute to creating the illusion of depth in 3D Graphics.

[6 marks]

i) Perspective.

(3 marks)

ii) Hidden Surface Removal.

(3 marks)

	Do not write in this column

6 marks

c) 3D graphics viewport.

[7 marks]

i) Explain what a viewport is.

(1 mark)

ii) Explain how a viewport can be used to enlarge or show a portion of an object inside a window.

(2 marks)

iii) Modify the code of the function shown in Code box 1 in order to create a viewport half the size of the entire window but having the same aspect ratio, and positioned in the centre of the window. The parameters w and h contain the width and the height of the window, in pixels.

(4 marks)

```
void myFunction (int w, int h)
{
   glViewport (0, 0, w, h);
   glMatrixMode (GL_PROJECTION);
   glLoadIdentity ();
   glFrustum (-1.0, 1.0, -1.0, 1.0, 1.5, 20.0);
   glMatrixMode (GL_MODELVIEW);
}
```

Code box 1

Do not write in this column

	7 marks

d) For each of the following statements about the 3D graphics pipeline, state if it is true or false and justify your answer.

[6 marks]

i) The main purpose of the pipeline is to increase modelling efficiency.

(2 marks)

ii) The pipeline architecture contains four transformation steps.

(2 marks)

iii) The final step of the pipeline is removing parts of the model which are outside the camera view.

(2 marks)

	Do not write in this column
	6 marks

Question 1 in total: $\frac{}{6} + \frac{}{6} + \frac{}{7} + \frac{}{6} = \frac{}{25}$

Question 2

a) Consider the display callback function shown in Code box 2.

[8 marks]

```
void mydisplay(){
     glClear(GL_COLOR_BUFFER_BIT);
      glBegin(GL_POLYGON);
            glVertex2f(-0.5, -0.5);
            glVertex2f(-0.5, 0.5);
            glVertex2f(0.5, 0.5);
            glVertex2f(0.5, -0.5);
      glEnd();
      glFlush();
}
```

Code box 2

i) Assuming that the OpenGL state machine is in its default state, sketch the 2D graphics output inside its window (draw the window as well).

(2 marks)

ii) Sketch the new graphics output after the user has enlarged the window to be twice as tall as it used to be, while still having its original width.

(2 marks)

iii) Write the reshape callback function which ensures that the graphics output conserves its initial aspect ratio when the window's height is increased.

(4 marks)

	Do not write in this column

	8 marks

b) The modelview duality.

[6 marks]

i) Give two examples of OpenGL modelling transformation function.

(2 marks)

ii) Give one example of OpenGL viewing transformation function.

(1 mark)

iii) Explain why OpenGL uses only one matrix for modelling and viewing transformations.

(3 marks)

	Do not write in this column
	6 marks

c) Homogenous coordinates.

[5 marks]

i) Explain what a homogenous coordinate system is.

(2 marks)

ii) Why are homogenous coordinates used in 3D Graphics?

(2 marks)

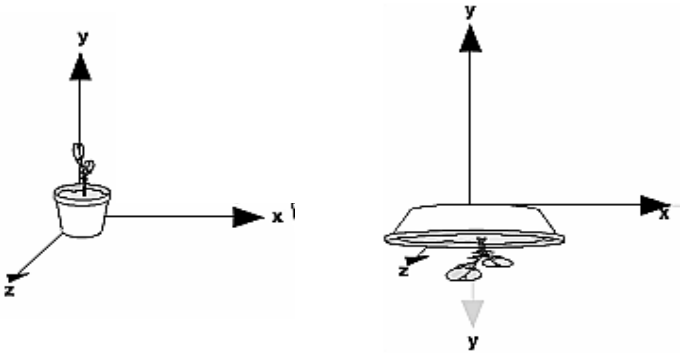
iii) Give valid homogenous coordinates for the following 3D point: A(2,3,1)

(1 mark)

	Do not write in this column
	5 marks

d) Starting from the object model shown on Figure 1 a), find the single modelling transformation that can create the object instance shown in Figure 1 b). Give the corresponding OpenGL command with appropriate arguments. Justify your choice of transformation and arguments.

[6 marks]



a) **b)**

Figure 1

	Do not write in this column
	6 marks

Question 2 in total: $\frac{}{8} + \frac{}{6} + \frac{}{5} + \frac{}{6} = \frac{}{25}$

Question 3

a) Briefly describe and contrast the two following modelling techniques:

[6 marks]

i) Surface modelling (polygon mesh).

(4 marks)

ii) Iterative modelling (fractal object such as the Sierpinski gasket).

(2 marks)

	Do not write in this column
	6 marks

b) Consider the display callback function code shown in Code box 3. Would you describe this code as linear or hierarchical modelling? Justify your answer by commenting on any dependency or lack of dependency between the various parts.

[6 marks]

```
void display(){
  gluLookAt(1.0, 1.0, 1.0, 0.0, 0.0, 0.0, 0.0, 1.0, 0.0);
  glPushMatrix();
  glRotatef(angle1, 0.0, 1.0, 0.0);
  part1();
  glTranslatef(0.0, PART1_HEIGHT, 0.0);
  glRotatef(angle2, 0.0, 0.0, 1.0);
  part2();
  glPopMatrix();
  glPushMatrix();
  glRotatef(angle1, 0.0, 1.0, 0.0);
  glTranslatef(0.0, PART1_HEIGHT, 0.0);
  glRotatef(angle2, 0.0, 0.0, 1.0);
  glTranslatef(0.0, PART2_HEIGHT, 0.0);
  glRotatef(angle3, 0.0, 0.0, 1.0);
  part3();}
```

Code box 3

	Do not write in this column
6 marks	

c) Suppose that you want to apply three modelling transformations (rotation R, scaling S and translation T) to a GLU cylinder which is aligned with the z axis and has its base in the plane z=0.

[6 marks]

i) With such a starting point, in which order should you apply the three transformations?

(2 marks)

ii) In an OpenGL program, in which order should the transformation statements be specified?

(2 marks)

iii) How is the current transformation matrix calculated?

(2 marks)

	Do not write in this column
6 marks	

d) Consider the image of a cube shown in Figure 2.

[7 marks]

i) What type of projection transformation has been applied to the cube? Justify your answer.

(4 marks)

ii) With respect to the two shading modes in OpenGL, what type of shading has been applied to the cube? Justify your answer.

(3 marks)

Figure 2

	Do not write in this column

	7 marks

Question 3 in total: $\frac{}{6} + \frac{}{6} + \frac{}{6} + \frac{}{7} = \frac{}{25}$

Question 4

a) What shading technique can be used to obtain the object shown in Figure 3 while declaring only one shade of grey? How does it work in OpenGL?

[6 marks]

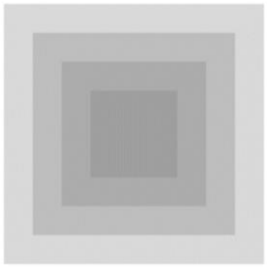


Figure 3

	Do not write in this column
	6 marks

b) In the OpenGL lighting model, there are different kinds of light.

[6 marks]

i) What kind of OpenGL light approximates best a red laser beam in a lab that produces a very bright spot where it strikes an object? Justify your answer.

(3 marks)

ii) What OpenGL light source property can best approximate sun light? Justify your answer.

(3 marks)

	Do not write in this column
	6 marks

c) Consider the object shown in Figure 4.

[5 marks]

i) What kind of OpenGL light is being used to illuminate the object of Figure 4?

(1 mark)

ii) What are the properties of this kind of light and what effect does it have on the surface of an object?

(4 marks)

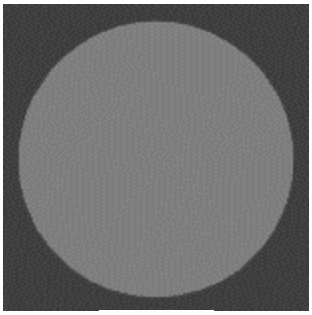


Figure 4

	Do not write in this column
	5 marks

d) Explain the following statement by providing an example: "In OpenGL, the material colour components actually determine the percentage of incident light that is reflected".

[5 marks]

	Do not write in this column
	5 marks

e) In an OpenGL program, how can you make sure a light source tracks the changing position of an object that is animated?

[3 marks]

	Do not write in this column
	3 marks

Question 4 in total: $\frac{}{6} + \frac{}{6} + \frac{}{5} + \frac{}{5} + \frac{}{3} = \frac{}{25}$

Use this section for rough work

	Do not write in this column

Use this section for rough work

	Do not write in this

Use this section for rough work

	Do not write in this