



北京邮电大学

EBU5405 A

Joint Programme Examinations 2017/18

EBU5405 3D Graphics Programming Tools

Paper A

Time allowed 2 hours

Answer ALL questions

Complete the information below about yourself very carefully.

QM student number

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BUPT student number

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Class number

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NOT allowed: electronic calculators and electronic dictionaries.

INSTRUCTIONS

1. You must **NOT** take answer books, used or unused, from the examination room.
2. Write only with a 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

For examiners' use only

1	
2	
3	
4	
Total	

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) Explain the following 3D rendering tasks:

[9 marks]

- i) Modelling transformations

(3 marks)

- ii) Viewing transformations

(3 marks)

- iii) Projection transformations

(3 marks)

[illegible]

b) For each OpenGL function below, state if it is a “primitive generating” function or a “state changing” function. Justify your choice.

[8 marks]

i) glVertex()

(3 marks)

- ii) glColor()

(2 marks)

- iii) `gluLookAt()`

(3 marks)

[illegible]

c) Consider the OpenGL code in Code box 1.

[8 marks]

- i) Find all the statements responsible for controlling what happens to the 3D objects when the window is changing size. Comment these statements.

(4 marks)

- ii) Find all the statements that could be removed from the program because they correspond to the default state of the OpenGL state machine.

(4 marks)

```
void myInit(void) {
    glClearColor(0.0, 0.0, 0.0, 1.0);
    glColor3f(1.0, 1.0, 1.0);
    glShadeModel (GL_SMOOTH);
}

void myfunction(int w, int h)
{
    glViewport(0, 0, w, h);
    glMatrixMode(GL_PROJECTION);
    glLoadIdentity();

    if (w <= h)
        gluOrtho2D(0.0, 640.0, 0.0, 480.0 * (GLfloat) h / (GLfloat) w);
    else
        gluOrtho2D(0.0, 640.0 * (GLfloat) w / (GLfloat) h, 0.0, 480.0);
}

int main(int argc, char** argv){
    glutInit(&argc, argv);
    glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
    glutInitWindowSize(640, 480);
    glutCreateWindow("3D Graphics");
    glutDisplayFunc(mydisplay);
    glutReshapeFunc(myfunction);
    myInit();
    glutMainLoop();
}
```

Code box 1

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[illegible]

Question marking: $\frac{-}{9} + \frac{-}{8} + \frac{-}{8} = \frac{-}{25}$

Question 2

a) This question is about geometric modelling.

[9 marks]

- i) Explain how “approximate encoding of surface geometry” can be achieved with polygons. **(4 marks)**
- ii) Explain why some 3D file formats restrict the surface mesh to triangular facets. **(3 marks)**
- iii) What would you change to the polygon mesh shown in Figure 1 to obtain a better approximation of the object it represents?

(2 marks)

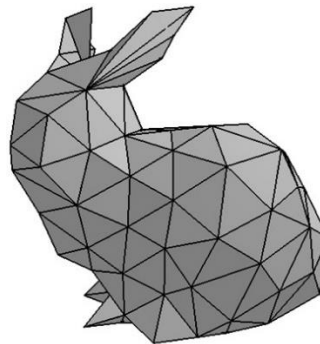


Figure 1

[illegible]

[illegible]

b) This question is about modelling transformations. Consider the two segments shown in Figure 2.

[8 marks]

- i) Describe the modelling transformation that has been applied to the first segment (shown on the left) in order to obtain the second segment (shown on the right). **(2 marks)**
- ii) How can you achieve the transformation you described above using OpenGL functions? **(3 marks)**
- iii) Construct the resulting 3x3 transformation matrix. Show your calculations. **(3 marks)**

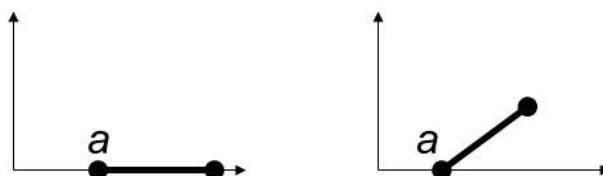


Figure 2

[illegible]

c) This question is about viewing transformations.

[8 marks]

- i) Give one OpenGL function that can be used to request a new viewpoint on the 3D scene. Explain its arguments.

(4 marks)

- ii) Using the function you identified above, how do you get a point (xyz) to appear in the centre of the 3D scene?

(1 marks)

- iii) Explain why viewing transformations and modelling transformations use the same OpenGL matrix (the MODELVIEW matrix).

(3 marks)

[illegible]

Question marking: $\frac{-}{9} + \frac{-}{8} + \frac{-}{8} = \frac{-}{25}$

Question 3

a) This question is about illumination and lighting calculations.

[9 marks]

- i) You are modelling and rendering a 3D outdoor scene. What kind of light source should you set up? Justify your answer by explaining the properties of the light source you chose. **(6 marks)**
- ii) Explain why you may also want to set up some ambient light in your scene, in addition to the light source you chose in the previous question.

(3 marks)

[illegible]

b) This question is about objects' material properties and lighting calculations. Consider that your 3D object is illuminated with white light coming from one source positioned at a finite distance from the object.

[8 marks]

- i) Explain how you would set up your object's material properties so its surface appears red and shiny.

(5 marks)

- ii) Explain how you would set up your object's material properties so it appears entirely black.

(3 marks)

[illegible]

c) This question is about projection.

[8 marks]

- i) How do you implement a zoom-in operation using the OpenGL projection matrix?

(4 marks)

- ii) What are the pros and cons of using `glFrustum()` versus `glOrtho()` when doing projection in OpenGL?

(4 marks)

[illegible]

Question marking: $\frac{-}{9} + \frac{-}{8} + \frac{-}{8} = \frac{-}{25}$

(5 marks)

- (5 marks)**

[illegible]

b) This question is about the rendering pipeline and rasterisation.

[10 marks]

i) What is the input to the rasterisation task?

(3 marks)

ii) What is the output of the rasterisation task?

(3 marks)

iii) Explain one technique which aims at optimising triangle rasterisation.

(4 marks)

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	10 marks

c) Describe how you would render an object that is reflected in a mirror on the YZ plane.

[5 marks]

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[illegible]

Question marking: $\frac{1}{10} + \frac{1}{10} + \frac{1}{5} = \frac{1}{2}$

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