Two hours - online

The exam will be taken online.

This paper version is made available as a backup
In this event, only MCQ answers written in the boxes on the exam paper will be marked.
Use a SEPARATE answerbook for Section B.

EXAM PAPER MUST NOT BE REMOVED FROM THE EXAM ROOM

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Computer Graphics and Image Processing

Date: Friday 19th May 2017
Time: 14:00 - 16:00

Answer ALL Questions from Section A and ALL Questions from Section B

This is a CLOSED book examination

The use of electronic calculators is NOT permitted
Section A contains MCQ questions and is restricted, therefore we are unable to publish this Section.
Section B

Answer every question from Section B.

1. Why is a double buffer necessary in a graphics rendering system? (1 mark)

2. For 3D transformations, why do we use 4x4 matrices instead of 3x3 matrices? (1 mark)

3. What is meant by the duality of modelling and viewing? (1 mark)

4. In the context of perspective projection, what does the following matrix represent? (1 mark)

\[
\begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 1/d_z & 1
\end{bmatrix}
\]

5. What is meant by projection normalization and why is it used? (2 marks)

6. Figure 1 shows part of a screen displaying a grey triangle ABC and a red triangle DEF. ABC is scan-converted first. DEF is scan-converted second, and is closer to the camera than ABC. Referring to the 2 pixels P and Q, explain how the scan conversion process ensures that ABC and DEF are displayed correctly. (3 marks)

7. What is polygon soup? Discuss whether you think it is a good or bad idea. (2 marks)

8. Given a triangle ABC, explain how to compute the triangle’s normal vector. (2 marks)

9. What is the fundamental difference between local and global illumination? (1 mark)

10. What is the purpose of the expression \( k_s(\vec{R} \cdot \vec{V})^n \) in a simple local illumination model? In your answer explain the roles of each term and their ranges of values. (4 marks)
11. Describe a method for making a surface look bumpy that does not involve changing the actual geometry of the surface

12. Thresholding is intended to separate objects from background. Under what circumstances will this work? What properties of an image might cause the algorithm to fail? How could the algorithm be modified to reduce this problem?

13. Define an edge as it relates to image processing. Use this definition to derive an operator that will highlight edges

14. Figure 2 shows an image of the Earth taken from a polar orbiting satellite. It shows land (part of North Africa at the bottom), sea and cloud. How would you process this to identify the pixels that are land, sea and cloud and hence estimate the amount and thickness of the cloud cover?

15. Images are often corrupted by noise. What is noise? How would you measure the amplitude of the noise? How would you reduce the effect of noise in an image?
16. Describe a method to computing the area of a blob from a description of its outline. (2 marks)

17. How do you decide if two distant pixels are connected? (2 marks)

18. A central moment of area is defined by

\[ M_{ab} = \sum (x - \bar{x})^a (y - \bar{y})^b f(x,y) \]

What does the 00 moment of a blob define? How would you compute a blob’s centroid? (2 marks)