COM3404

UNIVERSITY OF EXETER

SCHOOL OF ENGINEERING AND COMPUTER SCIENCE
Department of Computer Science

Modelling and Animation

TWO HOURS

Answer question 1, and two out of the four other questions.
Question 1 is worth 40 marks. Other questions are worth 30 marks each.

Candidates are advised to spend FORTY-FIVE minutes on question 1
and THIRTY-FIVE minutes on other questions.

No electronic calculators of any sort are to be used during the course of this examination.

COM3404

Compulsory question

1. (a) A surface may be approximated by a set of polygons. Describe **three** possible techniques, including the *winged-edge* representation, for representing such a set of polygons.

(6 marks)

State the chief characteristics of a *Bézier patch*.

(4 marks)

(b) *'Rendering can be thought of as consisting of five basic components'* - O'Rourke (1995). Summarise these **five** components of the render pipeline. Choose any **two** of these components and describe in more detail the key methods and variables that are employed.

(12 marks)

(c) What are *storyboards* and how are they used to plan video and film sequences? Outline the key elements that are typically found in a well-developed storyboard. Illustrate your answer with a sketched example of **one** scene from a storyboard.

(9 marks)

(d) Explain what is meant by *post-production* in the context of video and film production. Outline **three** techniques that are commonly applied in post-production.

(9 marks)

(Total 40 marks)

Please Turn Over

2. (a) Explain the types of path which may be taken by a ray of light which is incident on an object.

(5 marks)

(b) Describe the main features of the following illumination models:

(i) Phong reflection model,

(7 marks)

(ii) radiosity lighting model.

(7 marks)

(c) State clearly where an illumination model would be invoked in each of the following algorithms:

(i) Gouraud shading algorithm,

(ii) Phong shading algorithm,

(iii) a simple ray tracing algorithm.

(5 marks)

(d) Discuss reasons why ray tracing is a much used approach to rendering.

(6 marks)

(Total 30 marks)

Please Turn Over

3. (a) Discuss briefly which aspects of a scene are commonly animated.

(6 marks)

Describe the following techniques for specifying animation, giving in each case an example where the technique might be appropriately used:

(i) key frame,

(ii) motion path,

(iii) lattice deformation (*squishy-box*),

(iv) inverse kinematics.

(16 marks)

(b) A car is moving anticlockwise round a circular track of radius R (modelled in the xz plane) at a constant speed of T seconds per revolution. The wheels of the car have radius r. Show how you would specify, in terms of the frame number, the following animations, assuming a frame rate of F frames per second.

(i) The translation of the car around the track.

(ii) The rotation of a wheel of the car.

Show, by means of a simple annotated sketch, a path and direction for a camera which makes one pass round the car (righthand side, front, lefthand side, back, righthand side) while the car completes one circuit. You should assume the camera moves in a fixed xz plane.

(7 marks)

(Total 30 marks)

Please Turn Over

4. (a) Outline the computer modelling and animation techniques that you would employ to create a realistic 3D rendering for each of the following scenes. Explain what methods you would use and how you would model each of the key elements described.

(i) Two balls of *potty-putty* bounce towards each other across a rough stone surface, they collide and merge to form a single large ball which bounces up and down.

(ii) A rocket takes-off and soars into the night sky. It erupts in a large shower of fireworks above a dense coniferous forest.

(14 marks)

(b) Explain in detail what is meant by a *particle system* including an account of the key control parameters that can be employed. What are typical uses of particle systems in computer modelling and animation?

(10 marks)

(c) How is *fractal geometry* used in 3D computer graphics, what are its advantages?

(6 marks)

(Total 30 marks)

Please Turn Over

5. (a) Explain how *solid* modelling differs fundamentally from *surface* modelling and list **three advantages** and **three disadvantages** of solid modelling in comparison with surface modelling.

(8 marks)

(b) The diagram below shows heights measured at the intersections of a rectangular grid. Sketch a copy of this diagram and show how the marching squares algorithm can be used to generate a contour with value of 4.5. On your sketch show the two possible outcomes which result from contouring ambiguity. Explain how this ambiguity arises and state how it might be resolved.

1	2	3	4	4	3	
2	5	5	6	4	4	
2	5	7	4	4	2	
3	4	4	6	5	3	
2	4	5	8	9	2	
1	2	3	4	4	1	

(9 marks)

(c) How is the marching squares algorithm extended for three-dimensional data? What methods can be used to resolve ambiguities in the three-dimensional case?

(5 marks)

(d) Describe the application of *ray-casting* to volumetric data. Explain, with examples, the role played by the *ray function* in volume visualisation using ray-casting.

(8 marks)

(Total 30 marks)

End of Paper