Section A - Answer ALL questions

1. Briefly explain the tradeoff between complexity and accuracy in 3D modelling.

(3 marks)

2. If you are designing a computer animation package (like Blender) how would you decide to represent orientations internally and why?

(4 marks)

What representation would you choose for user-defined orientations and why?

(2 marks)

3. Describe the **Angle+Axis** representation for rotations. State the theorem on which it is based. How do we interpolate orientation using this representation?

(5 marks)

4. Briefly outline what happens at the compositing stage of animation. Give THREE examples of special effects that make use of compositing.

(4 marks)

5. Enumerate the degrees of freedom of a 3d model of a bicycle. State clearly any assumptions you make.

(4 marks)

6. Which animation technique would you use to model each of the following:

a) A water fountain

b) A waving flag

c) A bowling alley

d) An airplane taking off

e) A snowflake

f) A crane picking up a load

g) Smoke

(7 marks)

7. An interpolation technique is known to be C2 continuous, and its order is N=3. Briefly explain what that means.

(4 marks)

8. Explain the steps involved in object deformation based on **FFD (free-form deformation)**.

(5 marks)

9. Name the FIVE different spaces that form part of the **display pipeline**.

(5 marks)

10. Give definitions of **forward and inverse kinematics**. Which one is harder to achieve? Give an example of an animation task for which EACH technique is more suitable.

(7 marks)

END OF SECTION A

Section B - Answer any TWO of the following three questions

11. This question is about **physics simulation**.

a) What type of scenes might be animated using physics simulation? Why is this aproach preferable to traditional techniques such as **keyframing**?

(2 marks)

b) Briefly explain what is meant by broad phase and narrow phase algorithms in the context of **collision detection**.

(4 marks)

c) Describe the **simulation loop** employed in physics-based animation of rigid bodies. You may give your answer in the form of a labelled diagram.

(7 marks)

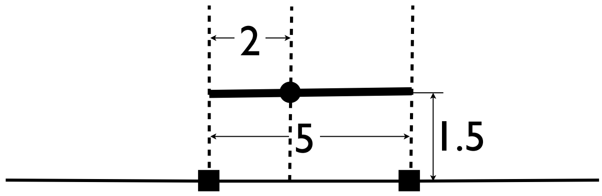
d) We wish to simulate an object of mass $m = 1$ that moves on the x-y plane under the influence of a constant gravitational field $F_g = (0,\ -2)$ and a windfield whose force is proportional to its velocity. The wind force is given by $F_w = -0.5v$. Its velocity initially (at frame 0) is $v = (4,\ 8)$ and its position is at $x = (0,\ 0)$. Use Euler's algorithm to calculate the position and velocity of the object in frames 1 to 3.

(12 marks)

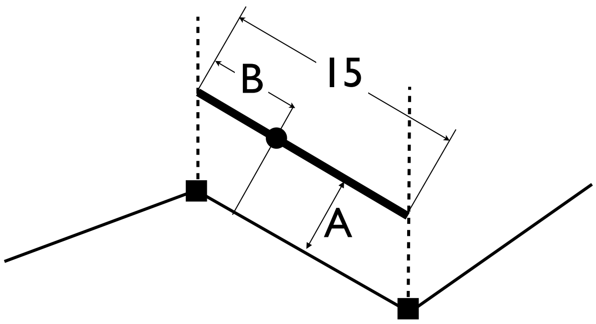
12. This question is about **non-rigid deformation**.

a) Give a brief description of **direct vertex manipulation**. (6 marks)

b) The following diagram shows a 2d skeleton at rest, with three bone segments as well as an object vertex (round dot) that has been assigned to the middle segment.



The diagram below shows the same skeleton and the object vertex undergoing a deformation.



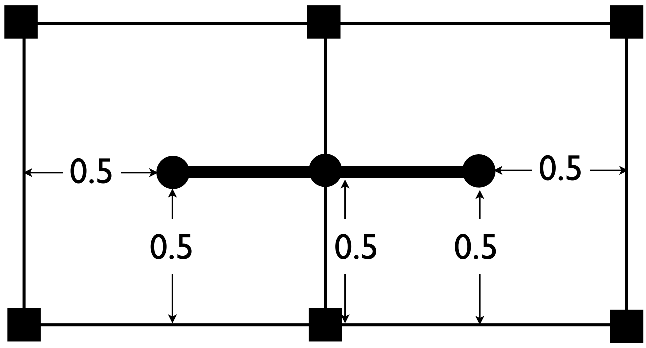
Using the distances indicated on the two diagrams, derive the distances denoted by A and B.

(4 marks)

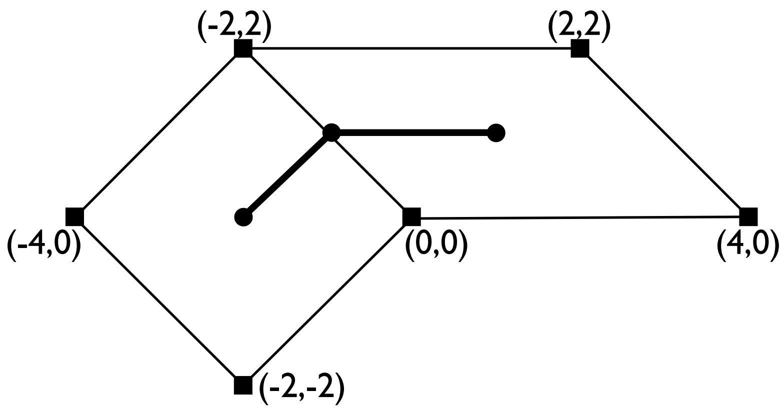
(question continues on next page...)

(Question 12 continued. . .)

c) This part is about 2d grid deformation using **bilinear interpolation**.



(Figure 1)



(Figure 2)

Figure 1 shows a simple 2d object consisting of three vertices (round dots) that is embedded into a 2×3 lattice. In Figure 2 the grid points have been dragged to the new positions shown. Use **bilinear interpolation** to obtain the deformed positions of the three object vertices in this new configuration. (15 marks)

13. Two widely used methods for generating and animating natural objects and phenomena are **L-systems** and **particle systems**.

a) Explain what L-systems are and how they are used to generate models of natural objects. (8 marks)

b) Give the output of the initial state and the first TWO iterations of the following L-system:

```
Axiom F
F→F+F---F+ angle = 60°
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BOTH in string representation AND in graphical form. (9 marks)

c) Describe what particle systems are and how they are used to create animated effects. Name TWO examples of phenomena that can be modelled by particle systems. (8 marks)

END OF EXAMINATION PAPER